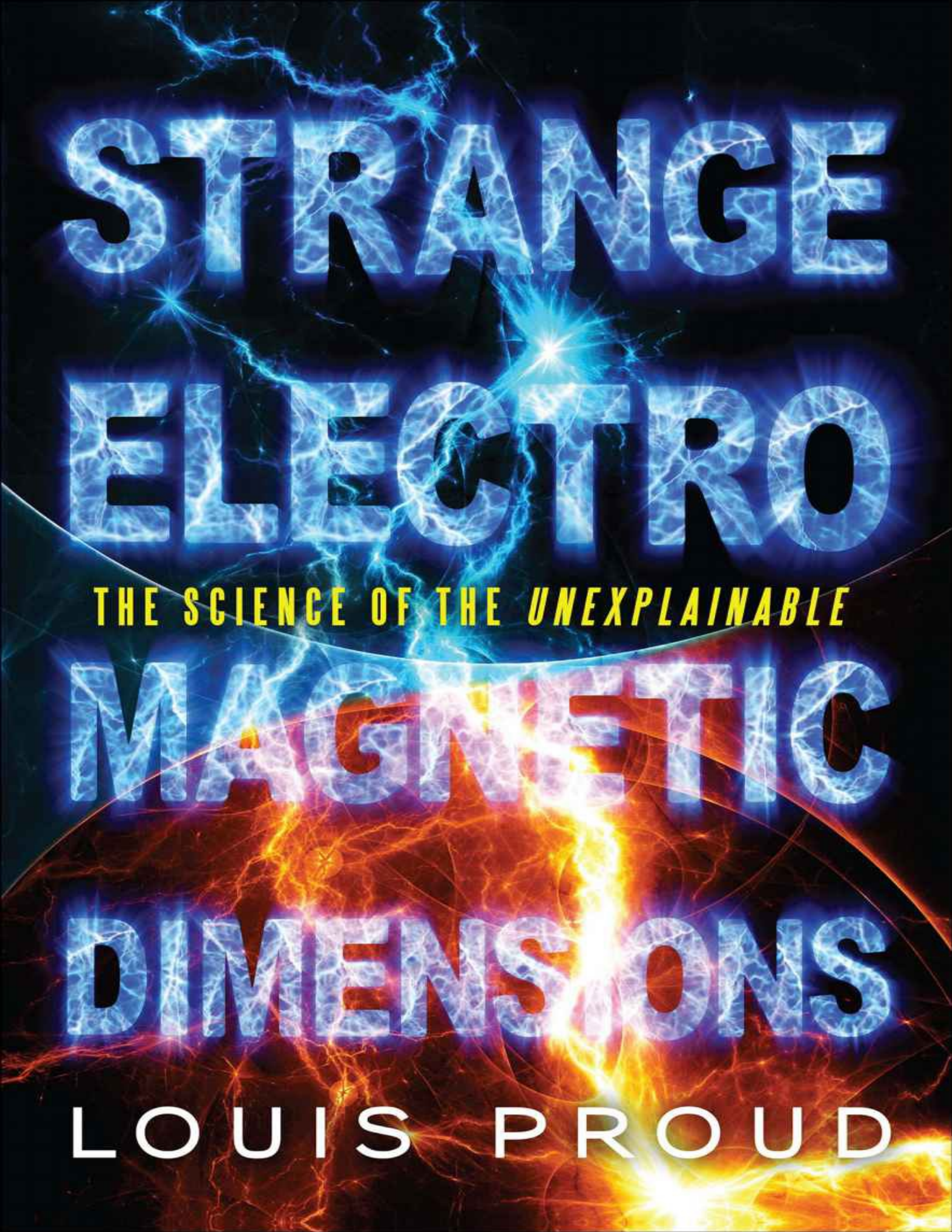
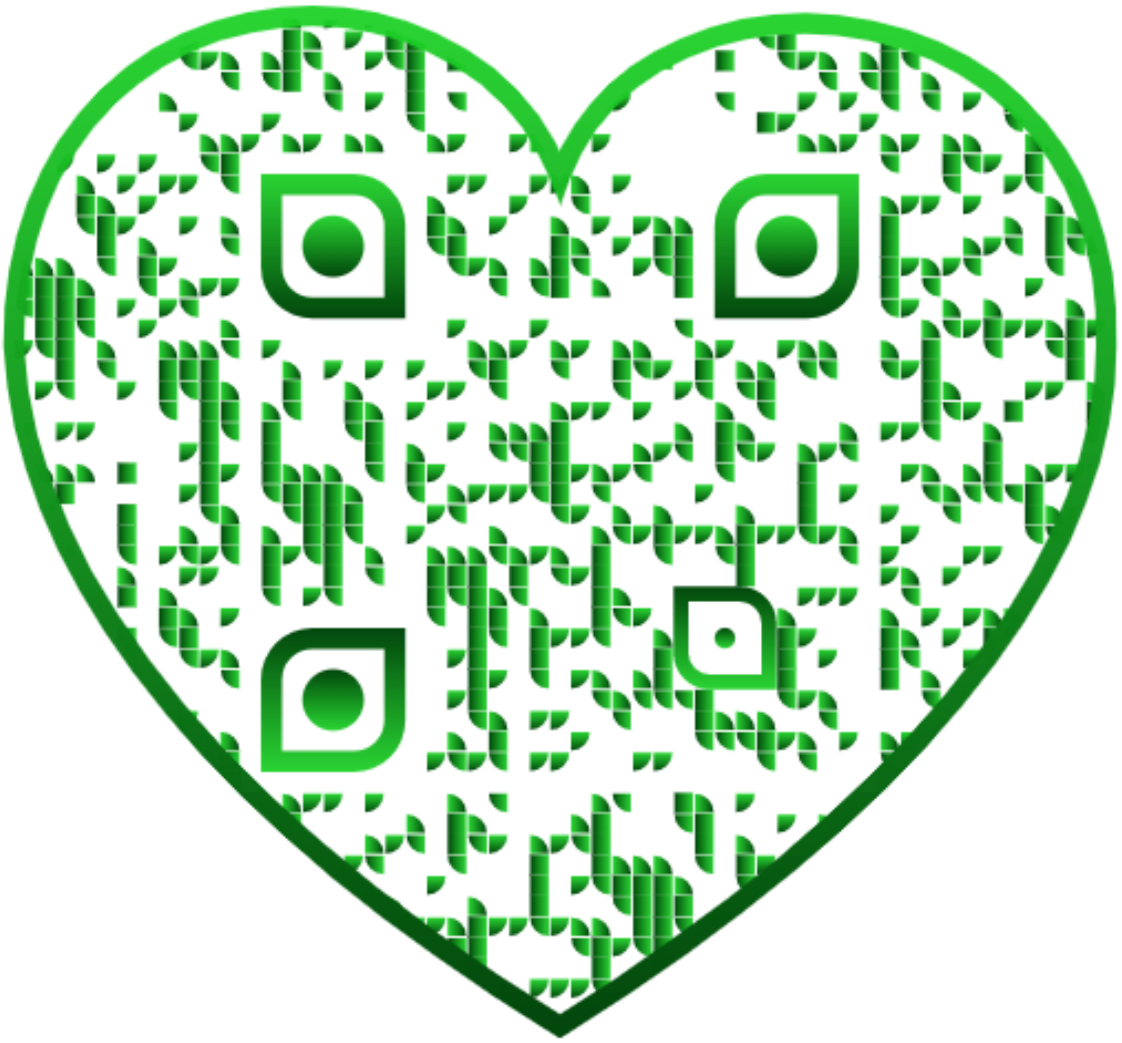

STRANGE
ELECTRO
THE SCIENCE OF THE UNEXPLAINABLE
MAGNETIC
DIMENSIONS
LOUIS PROUD



STRANGE ELECTROMAGNETIC DIMENSIONS

The Science of the Unexplainable

■

LOUIS PROUD

NEW PAGE BOOKS
A division of The Career Press, Inc.
Pompton Plains, NJ

Contents

Introduction

Chapter 1: Of Turtles, Cows, Mice, and Men

Chapter 2: The Electromagnetic Pulse of Life

Chapter 3: Allergic to Electricity

Chapter 4: Fire from Heaven

Chapter 5: Transformed by Lightning

Chapter 6: Electric People and Poltergeist Agents

Chapter 7: The Fifth Force

Chapter Notes

Bibliography

Index

About the Author

Introduction

I'm writing this on a computer connected to the internet by means of a wireless modem. The ceiling fan above me is rotating softly, keeping the edge off the heat. Mounted on the wall to my right is a compact fluorescent lamp, its bluish-white glow illuminating the room. A cellphone rests on the edge of the bookcase. Each of these devices—and many others in my home—emit electromagnetic (EM) radiation within a certain portion, in some cases multiple portions, of the EM spectrum.

Just as ancient man learned to harness fire, using it to cook food, provide lighting, and keep warm, so did modern man learn to harness EM energy. Today we cook our food in electric ovens, use electric lights, and heat our homes with electric heaters. We live in an age of EM wizardry, the limits of which seem endless.

Most of us take electricity and its attendant technology for granted, only realizing how much we depend on such things as electric lights on those rare occasions when there's a power outage or when we go on a camping trip. As someone who spent a significant portion of their upbringing in a home without mains electricity—we lacked the funds required to have it connected—I have some understanding of the difficulties of living without it.

We used candles and kerosene lanterns in place of electric lights and a wood stove in place of an electric stove. No electricity meant no hot water from the tap. Having a warm bath required heating the water on the stove. Later, we purchased an old chip heater (named as such because it ran on wood chips) to produce hot water for baths. I ironed my shirts for school using an antique iron made from heavy cast iron. The idea was to place this on the top of the stove until it had reached the desired temperature. My grandmother became nostalgic whenever she came to stay with us, commenting on how our primitive lifestyle reminded her of her upbringing in 1920/30s rural South Australia.

The use of electricity on a large scale is a fairly new development in the history of humanity, having only really started in the 20th century with the establishment of power stations and electricity grids. "The experience of living or working in artificial electromagnetic fields superimposed upon the natural background electromagnetic environment is, in evolutionary terms, extremely new to humans—perhaps no more than 40–50 years old as far as industrial and domestic exposure is concerned," explain Cyril Smith and Simon Best.[1] Considering these words were written in 1989, roughly 25 years ago, it would be more accurate to say that humanity's exposure to artificial EM fields has been going on for 65 to 75 years. This, nonetheless, is a very brief period of time.

It's fascinating to realize that the environment in which my grandmother lived during her formative years was relatively free of artificial EM fields, whereas today the opposite is true for the majority of humanity (including for my grandmother, who nowadays resides in a house in the city).

In this book we'll take a look at the many and varied ways exposure to artificial EM fields has affected, and is affecting, both humanity and the world we inhabit, not only in relation to

matters of health and well-being but also in relation to matters of a paranormal nature. By "paranormal" I mean those things not currently understandable in terms of known scientific laws and phenomenon. Years of research have opened my eyes to the fact that just about every phenomenon deemed paranormal, from poltergeistry to UFOs, possesses an EM dimension—hence the title of this book.

It's no coincidence that many of the world's most significant paranormal movements and manifestations came about during the period from the mid-19th century to the mid-20th century—for example, the modern spiritualist movement in 1848 and the modern UFO era in 1947—at the same time humanity began to alter, in a way never before seen, the EM nature of the environment with the invention of electric telegraphy, telephony, radio, radar, television, and large-scale power generation and distribution, rendering the planet abuzz with new and exotic energies. As our use of technology continues to expand, and as new technologies come into being, we're pushing further and further into the EM spectrum, invading what was previously unoccupied.

Although it's true that many of the topics dealt with in this book are strange and controversial, I've tried to employ, as best I can, a down-to-earth approach and to back up my findings with scientific evidence. If you're after a purely sensational book filled with dubious stories of crashed alien saucers and the like, I suggest you read no further. When, as a teenager, I first became interested in paranormal matters, my appetite for such stories was immense and I accepted at face value much of what I read. Now older and (hopefully) more mature, I'm better able to appreciate the *real* mysteries, those that have some basis in fact and are open to scientific study.

How, for example, do balls of lightning pass straight through walls and panes of glass without hindrance? How does a single ball of lightning split into two or more smaller balls, each floating off in a different direction? What are we to make of cases where the object observed clearly exhibited a rudimentary form of intelligence, such as by carefully exploring a person's bedroom before exiting via the window it entered?

The topic of lightning occupies an important place in this book. In fact, my original aim when planning this project was to write exclusively about lightning, paying particular attention to cases where people had been struck by lightning and lived to tell the tale. I was amazed to learn that a small yet not insignificant percentage of lightning strike survivors had been struck by lightning not once but two or three times (in some cases more), as though possessed of the ability to draw lightning from the sky, albeit unintentionally. I wanted to learn more about these "human lightning rods" and, if possible, shed some light on their strange affinity with this powerful and spectacular natural force.

I soon became aware of additional anomalies in connection with lightning strike survivors. For example, it's not uncommon for survivors to claim that electrical devices repeatedly malfunction in their presence for no apparent reason, the problem having started after they were struck by lightning. Evidence suggests that being struck by lightning, though generally harmful, even deadly, can alter the body in such a way as to endow the person concerned with some very strange abilities. Discussed in this book are a number of cases of lightning strike survivors who have gone on to become psychics and shamans.

Being struck by lightning is not that far removed from receiving a severe electric shock. Indeed, lightning strike victims and electric shock victims very much belong in the same category, with similar injuries and effects experienced by both. If you gathered together a group

of genuine psychics you'd find that a notable percentage of the group were either struck by lightning (directly or indirectly) at a young age, or, more likely, suffered at a young age a severe electric shock.

In the preface to Matthew Manning's first book, *The Link*, the British publisher Peter Bander comments on a study conducted by Dr. Joel Whitton, a Canadian psychiatrist, on a group of well-known psychics. The study found that several of the psychics "had all suffered a severe electric shock before the age of ten."[2] Bander was curious to know if the same was true of Manning. He discovered that Manning's mother had suffered a severe electric shock three weeks before giving birth to him, even fearing that she might lose him. Manning's innumerable psychic abilities, which include affecting electrical equipment and moving compass needles, have been studied by scientists and found to be most likely genuine. Today he's a world famous healer.

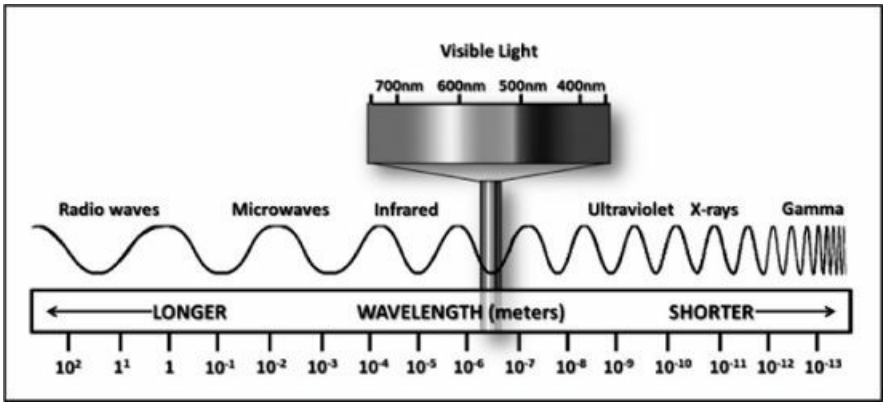
Of course, one needn't be an accomplished psychic to affect electrical equipment in strange ways. Plenty of "average Joes" claim this ability, particularly with respect to streetlamps. The latter phenomenon, called streetlamp interference (SLI), is surprisingly common. In a typical SLI incident, one or more streetlamps will suddenly blink out when approached, only to suddenly blink on again the moment the individual steps away. I discuss SLI in Chapter 6 and demonstrate that not all incidents of SLI can be attributed to coincidence and other mundane factors.

Other topics dealt with in this book include poltergeistry, psychokinesis (PK), UFOs, electromagnetic hypersensitivity (EHS), high voltage syndrome (HVS), animal and human magnetoception, and the relationship between geomagnetic disturbances and human health. These phenomena, when examined deeply and in relation to each other, raise a multitude of intriguing questions as to the function of electricity within the human body. If this book has one main purpose, it is to illustrate the profound extent to which EM processes apply to human beings and to the reality we collectively inhabit.

1 Of Turtles, Cows, Mice, and Men

The electromagnetic spectrum

What we perceive with our eyes is but a tiny fraction of reality. This tiny fraction of reality—what's known as visible light—occupies less than one percent of the EM spectrum. The EM spectrum is the range of wavelengths over which EM radiation extends. What we refer to as "light" is simply that portion of the EM spectrum that the human eye can detect, ranging from violet (with a wavelength of 400 nanometers [nm]) at one end to red (with a wavelength of 700 nm) at the other end. We only have to look at a rainbow in the sky, or see light pass through a prism, to know that the colors between violet and red consist of indigo, blue, green, yellow, and orange. This gives us a total of seven colors, each with its own wavelength.



The Electromagnetic Spectrum. Image courtesy of NASA.

Often we use the terms "ultraviolet" and "infrared" without truly knowing what they mean. Of course, the human eye cannot perceive either, since they lie outside the visible spectrum. "Ultra" means "beyond the range of," while "infra" means "below." Ultraviolet radiation is that portion of the EM spectrum *beyond* violet—namely, between violet and X-rays (ranging from 400 nm to 10 nm). Infrared radiation, which is synonymous with heat, exists *below* the red end of the spectrum—namely, between red and microwaves (ranging from 700 nm to 1 mm). The EM spectrum extends even further in both directions, encompassing, in addition to the above, radio waves, microwaves, extremely low frequency (ELF) waves, and gamma rays.

Wavelength and frequency are inversely proportional: the bigger the wavelength, the lower the frequency; the smaller the wavelength, the higher the frequency. If EM waves were animals, ELF waves would be the dinosaurs of the EM spectrum, with wavelengths up to thousands of kilometers. One natural source of ELF waves is lightning. Because they can penetrate sea water to depths of hundreds of kilometers, ELF waves are used by the military for radio communication with submerged submarines. Shorter waves lack this ability—they are absorbed

by the conductive sea water. ELF waves can travel long distances without appreciable attenuation, in the same way a charging Triceratops can bust through your house, and then through your neighbor's house, and still keep going.

The difference between ionizing and non-ionizing radiation

The EM spectrum is divided into ionizing radiation and nonionizing radiation, a division that occurs in the ultraviolet range. Basically, the non-ionizing part of the spectrum encompasses ELF waves, radio waves, microwaves, infrared, the visible spectrum, and part of the ultraviolet portion, while the ionizing part of the spectrum encompasses the rest of the ultraviolet portion, X-rays, and gamma rays. As a rule of thumb, EM energy of large wavelength (low frequency) is non-ionizing; EM energy of small wavelength (high frequency) is ionizing.

The difference between ionizing and non-ionizing radiation comes down to energy. Given that the energy of EM radiation is inversely proportional to wavelength, it follows that shorter (higher frequency) waves carry more energy than longer (lower frequency) waves. Let's imagine there are two children holding a skip rope between them, each pulling their end up and down so as to create waves in the rope. The more energy applied by the children, the more waves there will be in the rope. Hence, too, the wavelength will be shorter and thus the frequency higher. (Frequency is measured in Hertz (Hz), which means cycles per second, with 1 Hz equaling 1 cycle per second.)

We've already taken a brief look at ELF waves, which lie at the far end of the non-ionizing section of the EM spectrum. At the other far end of the spectrum, within the ionizing section, we find gamma rays. Gamma rays come right after X-rays; therefore they carry more energy than X-rays. They are in fact the most energetic form of EM radiation, and can penetrate matter with ease. Even a thick sheet of lead will fail to block them entirely. They are emitted during radioactive decay, such as that of uranium, an important nuclear fuel. Ionizing radiation is harmful to living cells, so we're fortunate that the atmosphere of the Earth blocks out gamma rays, X-rays, and other forms of ionizing radiation. Intense or prolonged exposure to gamma rays can result in serious illness (radiation poisoning) or death.

Simply put, ionization is the process whereby one or more electrons are removed from an atom. Ionizing forms of radiation, such as gamma rays, ionize the matter through which they come in contact, stripping electrons from atoms. "When the body's cells are exposed to [ionizing] radiation," explains Dr. Carolyn Dean, "the DNA and proteins inside the cell become 'ionized,' which means that the electrons inside the atoms that make up the cell's components are 'knocked out,' and the DNA and proteins become damaged and lose proper function."[1] Cells that have been damaged in this fashion usually die, although some manage to repair their DNA. If the repair is incorrect, however, it can lead to mutation and possibly cancer.

Given its ability to alter atoms by stripping them of their electrons, thereby causing damage to cells, ionizing radiation is obviously nasty stuff. But even though non-ionizing radiation lacks the energy required to affect atoms in this fashion, it too can be harmful to living things. When it comes to the issue of biological effects resulting from exposure to non-ionizing radiation, much is known from a thermal perspective, though little is known from a non-thermal perspective. We'll explore the possibility of non-thermal effects in a later chapter, but for now let's take a look at the thermal effects.

These days just about everyone has a microwave oven in his or her home. A microwave oven generates microwaves (of around 2,450 megahertz) by means of a kind of electron tube, called a

magnetron. The radiation is absorbed by the food placed inside the oven, exciting the atoms that make up the food and thereby causing the food to be heated from within. Only those substances that absorb microwaves can be heated by them, such as the water, fats, and sugars. Microwaves pass quite easily through glass and polyethylene—hence the reason microwave containers are generally made from these substances. Metallic substances such as aluminum foil, on the other hand, deflect microwaves, and so aren't "microwave friendly."

Just as a piece of chicken would get cooked if placed inside a microwave oven for a sufficient period of time, so too would a human hand. The microwaves would heat your tissue to the point where it would be irreversibly damaged. This example illustrates the fact that non-ionizing radiation, though generally considered harmless, has the potential to be just as dangerous as ionizing radiation.

Infrared and ultraviolet vision

I live in Darwin, Australia, which is known for its abundance of crocodiles, snakes, and other reptiles. Though none exist in Australia, there is a family of snakes known as pit vipers, named as such because of their heat-sensitive pit organs, located between each eye and nostril. These organs constitute a "sixth sense," enabling the snake to detect infrared radiation. Most species of pit viper are nocturnal; they hunt at night, when temperatures have cooled down, making use of their special organs to locate warm-blooded prey such as rodents.

Mosquitoes, too, have infrared vision. You could be standing perfectly still on a pitch black night yet mosquitoes will still manage to find you, as they are attracted to the heat emitted by your body.

Some animals can see into the ultraviolet portion of the spectrum. In fact, many species of bird have UV-sensitive vision, only it doesn't extend very far into the UV realm; they can see only one of the three bands of UV radiation—that which lies nearest to visible light, known as UVA (400–315 nm). The two remaining bands are UVB (315–280 nm) and UVC (280–100 nm), these being shorter in wavelength to UVA.

UVB can have a harmful effect on humans and other living things, causing skin cancer and eye damage. For this reason scientists were inclined to assume that no creature had the ability to perceive UVB. This assumption was disproven in 2007, when it was discovered that the species of jumping spider *Phintella vittata* can indeed sense UVB. These strikingly patterned spiders have specialized surfaces on their bodies that reflect UVB. They use these reflective surfaces to communicate with each other privately. Experiments have shown that during courtship, the female of the species shows significantly less interest in the male when the spiders are placed in an environment with a UVB-blocking filter, compared to normal conditions.

Given that snow is extremely reflective of sunlight, with an albedo that can reach as high as 90 percent, you'd be foolish not to wear a pair of sunglasses if you're planning to spend a lot of time in the snow. Anyone who has suffered from "snow blindness" (photokeratitis), caused by overexposure of UV to the eyes, would know how painful it is. Sufferers liken the sensation to having sand in their eyes. The Inuit took measures to prevent the occurrence of snow blindness by wearing "snow goggles" fashioned from caribou antler. The goggles have a thin slit down the middle, through which the wearer peers out, greatly limiting the amount of UV that is able to reach the eyes.

Unlike humans, arctic reindeer don't have to worry about snow blindness: their eyes are perfectly adapted to the UV-rich environment of the arctic, such that they have perfect access to

the UVA portion of the spectrum. Whereas humans can see very little in the all-encompassing whiteness of the arctic, the reindeer that live there can see virtually everything. Things that absorb UV, such as the lichen on which they feed and predators like wolves, would to them appear dark against the snow. Clearly, were it not for their UV-sensitive vision, the arctic reindeer would be unable to survive. It is now believed that many arctic animals, not only reindeer, possess UV sensitivity.

An Inuit man wearing snow goggles. Image courtesy of Julian Idrobo, Wikimedia Commons.

Scientists are discovering more and more all the time about the remarkable sensory capabilities possessed by different animals. Gradually we are beginning to realize that our precious visible spectrum is narrow in the extreme. In fact, when compared to other animals, humans are rather exceptional in *not* being able to perceive either infrared or ultraviolet. For a reindeer grazing in the snow, or for a rattlesnake hunting its prey in the cool night of the desert, there is a whole other dimension of reality to which we humans are blind.

Earth's magnetic field

Every creature on Earth is immersed in a "sea" of EM energy from both natural and artificial sources. It's easy to forget that the Earth is more or less a giant magnet, and that we spend each moment of our lives wrapped up within its constantly fluctuating magnetic field, also known as the geomagnetic field.

The first magnetic compasses appeared during the 12th century and were used by mariners in both China and Europe. (It is believed that they invented the compass independently of each other.) These primitive devices consisted of a piece of lodestone—a naturally occurring magnetic ore—attached to a stick. It was noticed that the stick, when floated in water, would align itself in such a way as to point in the direction of the polestar. In place of lodestone, subsequent designs incorporated an iron or steel needle that had been given a magnetic charge through contact with a lodestone. A compass works by aligning itself with the Earth's magnetic field, enabling one to determine which way is north—and hence figure out any direction.

The English scientist William Gilbert (1544–1603)—who served as physician to Queen Elizabeth I during the final years of her reign—conducted pioneer research into magnetism and, to a lesser extent, electricity, experimenting with lodestone and pieces of amber (a good accumulator of static charge). Widely considered the founder of the modern sciences of electricity and magnetism, in 1600 he correctly concluded that a compass behaves the way it does because the Earth is a giant magnet.

If you place a bar magnet beneath a piece of paper and sprinkle the surface of the paper with iron filings, the iron filings align themselves with the dipole magnetic field that is present, rendering visible what was previously invisible. The magnetic field of the Earth is similar to that produced by a bar magnet, its magnetic lines of force having approximately the same pattern. Imagine the Earth from a distance with a large bar magnet buried in its center, the south end of the magnet facing toward the (geographic) North Pole and the north end of the magnet facing toward the South Pole. If the magnetic field lines of the Earth were visible, they would be seen emanating from the South Pole, curling up and crossing the equator, and then curling back around and entering the North Pole.

Of course, there is no permanent magnet buried within the Earth. Nor does this "magnet" line up precisely with the North and South Poles; the Earth's rotational axis is inclined 11.7 degrees with respect to its magnetic axis.

According to the widely accepted dynamo theory, the magnetic field of the Earth is generated deep within the planet, where heat produced by means of radioactive decay in the solid inner core drives convective motion in the liquid iron outer core. This activity produces an electric current, which in turn gives rise to a magnetic field.

The unit of measurement known as the gauss (named after the scientist Carl Friedrick Gauss) pertains to magnetic induction, but is also used in relation to magnetic field strength. Magnetic field intensity drops off rapidly with distance. Thus, the closer you are to the source of the field, the higher the reading will be. Deep underground, in the very core of the Earth, the strength of Earth's magnetic field is approximately 25 gauss. Here on the surface, the field is some 50 times weaker—that is, approximately 0.5 gauss. Considering that a small bar magnet measures approximately 100 gauss (200 times stronger), one gets the impression that Earth's magnetic field is extremely weak. The comparison is a misleading one, however, because Earth is a huge magnet, the volume of its field inconceivably larger than anything an artificial magnet could produce.

The first worldwide survey of the Earth's magnetic field was carried out in the 1830s. The brains behind this work was the brilliant German scientist Carl Friedrich Gauss (1777–1855). It was Gauss's invention of the magnetometer in 1832—an instrument used for measuring the strength of magnetic fields—that made this accomplishment possible. Records show that since Gauss's time the magnetic field of the Earth has weakened by approximately 10 percent, and that

throughout the last century, magnetic north has migrated more than 1,500 kilometers.

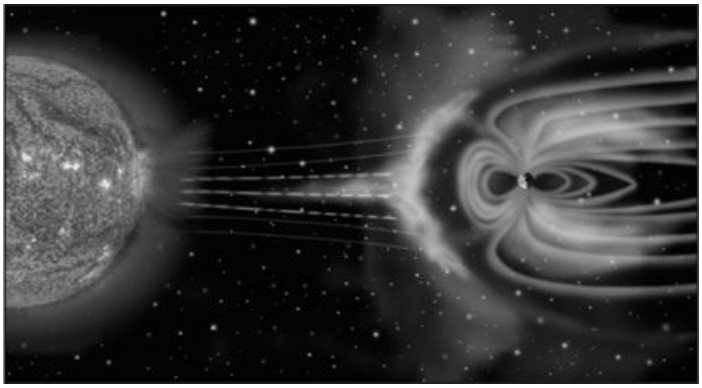
Geological evidence confirms that the Earth's magnetic field flips, on average, once every 200,000 years, with the most recent flip having occurred around 780,000 years ago. Scientists predict that the field will continue to weaken for the next 500 years, all but disappearing, at which point it will gradually reverse and build up in strength. That the Earth is overdue for a magnetic pole reversal is well established by scientists; though, as mentioned, this event is unlikely to occur for many hundreds of years. Nor is the event expected to occur suddenly; the evidence suggests that reversals are a gradual process.

A protective cocoon

In the 2003 sci-fi disaster film *The Core*, the Earth's core suddenly grounds to a halt. The result: the Earth's magnetic field begins to collapse, thereby rendering the planet—and all life on the planet—vulnerable to harmful space radiation. All of a sudden the Earth is ravaged by huge electrical storms, pacemakers cease to function and people die as a result, and birds, no longer able to navigate by means of the geomagnetic field, begin to behave erratically, even falling from the sky. A team of scientists backed by the U.S. Government craft an "ingenious" plan to kick the Earth's core back into action and consequently restore the Earth's magnetic field before it's too late: they will bore into the core itself and deposit a series of nuclear charges.

It's impossible to predict precisely what would happen if the magnetic field of the Earth suddenly collapsed, though no doubt the outcome would be rather less dramatic than what is presented in *The Core*. So just how important is the geomagnetic field in terms of protecting life on Earth?

Ejected from the Sun's corona, at a speed averaging 1,610,000 km per hour, is a continuous stream of plasma called the solar wind. The solar wind pushes back on the Earth's magnetic field, distorting it in such a way that it takes on the shape of a comet. We refer to this comet-shaped region as the magnetosphere. The "head" of the magnetosphere—the side facing the Sun—has a thickness of roughly 100 km, while the "tail" extends hundreds of thousands of kilometers into space. In short, Earth's magnetic field acts as a protective cocoon around the planet by deflecting away the solar wind and other forms of space radiation, similar to how the windscreen of a motorbike deflects incoming air and rain and so keeps the rider protected from the elements.



The Earth's magnetosphere. Image courtesy of NASA.

Like Earth, Mars possesses a roughly 24-hour day, clouds, winds, seasonal weather patterns, volcanoes, and polar ice caps. But although its surface is littered with patches of magnetism, it lacks a global magnetic field such as is found on Earth. Scientists are reasonably sure, however, that Mars possessed such a field up until four billion years ago. One compelling theory states that the planet's magnetic field collapsed after its core was shut down by a series of huge asteroid impacts. Precisely what caused this shutdown remains a mystery, yet we know it had a devastating impact on the planet. With no magnetic field to protect it, Mars's atmosphere was gradually stripped away by the solar wind, so that today it is virtually airless. Had Earth's magnetic field collapsed long ago, as in the case of Mars, it's unlikely we'd be here today, the atmosphere too thin to support life.

Mind you, Earth's magnetic field is hardly a perfect barrier against space radiation: it does experience some penetration by solar wind particles (high energy protons and electrons). Rather than make their way down to Earth, the particles get trapped at high altitude within the Earth's magnetic field, forming two torus-shaped regions called the Van Allen radiation belts. Named after the American physicist who discovered them in 1958, James A. Van Allen, the Van Allen radiation belts are precisely that—belts of ionizing radiation. The inner belt lies some 3,000 km above the Earth's surface and the outer belt from 15,000 to 20,000 km.

Adherents of the "Moon hoax" theory argue that the Apollo astronauts could not have landed on the Moon, let alone have travelled into outer space, because to do so would have meant passing through the Van Allen radiation belts, which, they say, no human being is capable of surviving. The major flaw in this theory is that the astronauts spent little time passing through these regions, so they weren't exposed to enough radiation to cause them any harm.

Animal magnetoception

Whether we recognize it or not, we are "tuned to" Earth's magnetic field, as is every other living creature on the planet. A wealth of scientific evidence shows that our bodies respond to fluctuations in geomagnetic activity, which is determined by both solar and lunar activity. So profound is our connection to the Earth's magnetic field that a number of studies indicate a clear and obvious link between geomagnetic activity and mental health. We'll examine some of this evidence in the next chapter. For now, let's take a look at how certain animals use the Earth's magnetic field to find their way around.

The ability to detect a magnetic field to perceive direction, altitude, or location is known as magnetoception. A huge number of animals have been identified as possessing some form of magnetoception, including turtles, lobsters, sharks, pigeons, mice, mole rats, bats, as well as insects such as fruit flies, and honey bees. It's even been observed in bacteria.

In 1975, Richard P. Blakemore, a microbiologist at the Woods Hole Oceanographic Institution University of New Hampshire, Massachusetts, was observing under the microscope some bacteria in a drop of water when he noticed something odd about the tiny, single-celled organisms: they always moved to the same side of the slide. Were they responding, he wondered, to the magnetic field of the Earth? To test this theory, he held a bar magnet up against the slide and continued to peer down his microscope. The bacteria, clearly responding to the introduced magnetic field, began to migrate in the opposite direction. Blakemore had discovered a new type of bacteria, one able to sense the Earth's magnetic field, calling them "magnetotactic."

Magnetotactic bacteria live in water and, being what are known as microaerophiles, require water with a low oxygen content. And since deep water has less oxygen than shallow water, they

tend to live in the deeper parts of their aquatic environments. Inside each bacterium is a chain of tiny magnetite crystals, which together form one long magnet. As the organism's internal magnet maintains its alignment with the Earth's magnetic field, so is the organism forced into the same position. Each bacterium, then, is like a miniature compass needle. In the Northern hemisphere, magnetotactic bacteria are "north seeking," moving north along the Earth's magnetic field lines. This of course takes them in a downward direction, and therefore into deeper water. In the Southern hemisphere they are "south seeking," which also takes them into deeper water. At the equator, both "north seeking" and "south seeking" bacteria exist.

The amazing loggerhead

Sea turtles are ancient, fascinating creatures. Among the oldest reptiles on the planet, they've been around for approximately 100 million years, which is long before the extinction of the dinosaurs. They are also ancient in terms of lifespan, in some cases living to be 100 years old. Of particular fascination to scientists is the ability of sea turtles to navigate vast distances. There are seven species of sea turtle in the world, and of these the most impressive navigator is the loggerhead.

The loggerhead gets its name on account of its exceptionally large head. Male loggerheads practically never leave the ocean. The female, by comparison, is slightly less aquatic, coming ashore to nest. Her nesting season follows a three to four year cycle, with up to seven egg-laying events per nesting season. The moment she's laid her eggs she covers them with sand and crawls back into the ocean, leaving her brood to hatch on its own.

A baby loggerhead sea turtle. Image courtesy of U.S. Fish and Wildlife Service.

The eggs hatch between 50 to 60 days later. The hatchlings, having dug their way through the sand, instinctively make their way toward the ocean. Once in the surf, they immediately start swimming, beginning a solo journey that takes them into the open ocean.

In North America, loggerhead hatchlings follow a migratory route around the North Atlantic Basin, entering the North Atlantic Gyre, a circular system of warm ocean currents. Here they have a much better chance of survival than if they were to remain in coastal waters; the birds and fish that eat them are more likely to be found in coastal waters. They spend six to 12 years of their life in the Gyre, in the process covering a distance of some 13,000 kilometers, all the while

skillfully navigating so as not to get swept away by currents that would take them out of this "safe zone." They return to the coastal waters of North America upon completion of their migratory journey, far larger than they were when they left.

That a newly hatched loggerhead, lacking the slightest amount of navigational experience, can make its way around the open ocean and return home six to 12 years later, completing a journey of thousands of kilometers, is remarkable to say the least. Kenneth Lohmann, a marine biologist at the University of North Carolina at Chapel Hill, has spent decades studying the navigational abilities of marine animals, with a special interest in long-distance ocean migrants such as salmon, elephant seals, spiny lobsters, and sea turtles.

In one study conducted by Lohmann and his team, newly hatched loggerheads were fitted in "bathing suits" and lowered into a circular pool of salt water surrounded by a magnetic coil system. The purpose of the bathing suits was not to make the turtles look cute—though it certainly had that effect—but so as to tether them, via a length of fishing line, to a mechanical arm above. This moved when the turtle moved, measuring its every turn.

One turtle at a time was placed in the tank. The system of coils surrounding the tank was used to generate a series of magnetic fields similar to those at key locations along the turtles' migratory route through the North Atlantic Basin. Lohmann and his team wanted to see if the turtles could correctly interpret these fields and hence work out which way to swim. One of the fields matched that of the west Atlantic near Puerto Rico, with most of the turtles swimming northeast. Another field matched that of the east Atlantic near the Cape Verde Islands, with most of the turtles swimming southwest. In both cases, had the turtles been in the wild, they would have stayed on course, remaining within the North Atlantic Gyre. According to Lohmann, "The major finding is the turtles can distinguish between the magnetic fields they encounter in different locations along a migratory route and they use these fields as navigational markers to guide them."[2]

Loggerheads are gifted with a highly advanced form of magnetoception, using the Earth's magnetic field as their own global positioning system (GPS) starting from the moment they first enter the ocean. Lohmann's research strongly suggests that the turtles are born with an inherited "magnetic map" particular to their area of origin. In other words, specific colonies of loggerheads are hard-wired from birth to navigate specific migratory routes.

Sadly, mankind hasn't been friendly to the sea turtle; most species are threatened or endangered, loggerheads the latter. For this reason, says Lohmann, biologists aren't allowed to "cut open their brains to investigate" the mechanism underlying their ability to read the Earth's magnetic field.[3] One idea put forward is that the animals have crystals of magnetite in their heads —a not unreasonable notion considering that magnetite is known to play a role in magnetoception in bacteria and other living things.

Magnetite-loaded cells

The iron oxide magnetite (Fe^3O_4) is the most magnetic of all the naturally occurring minerals on Earth. Brown or black in color, tiny particles of magnetite are present in almost all metamorphic and sedimentary rocks. Although it's common for the two words to be used interchangeably, magnetite and loadstone aren't necessarily synonymous. A rock can be very high in magnetite yet not fall under the category of loadstone. A loadstone is a rock (or piece of rock) so high in magnetite, pure or nearly pure, as to exhibit the properties of a magnet.

A sample of magnetite. Image courtesy of U.S. Geological Survey.

What concerns us here is not magnetite as it appears in rocks, but rather magnetite as it appears in living organisms. Numerous living things endowed with magnetoception contain, or are presumed to contain, magnetite crystals. The nano-sized magnetite crystals that exist inside magnetotactic bacteria are synthesized by the organisms themselves. Since in this case we're dealing with single-celled organisms, the crystals are easy to identify and their function clear. On the other hand, understanding how magnetoception works in the case of advanced life forms is an altogether more complicated matter, and so too is the process of identifying those magnetite-loaded cells responsible for sensing magnetic fields, called magnetoreceptor cells.

Magnetoception is a unique kind of sense. It is different in nature to the five common senses of taste, hearing, touch, smell, and sight. These, with the exception of touch, are linked to openings in the body that provide some kind of contact with the outside world. We taste via our tongues; hear via our ears; see via our eyes; and smell via our noses. Touch takes place via the skin. We refer to each of these—the ears, eyes, tongue, skin, and nose—as a sense organ.

Each sensory system in the body has its own set of sensory receptors. Sensory receptors are groups of specialized cells that respond to particular types of stimuli. For example, our eyes contain photoreceptors, cells sensitive to light, while our tongues and noses contain chemoreceptors, cells that respond to chemical stimuli. Sensory receptors respond to both external (outside the body) and internal (inside the body) stimuli, converting the stimuli energy received, such as light, heat, and sound, into electrical energy in the form of nerve impulses.

In a 2008 article, Ken Lohmann and fellow biologist Sönke Johnsen discuss the difficulties associated with understanding how animals perceive magnetic fields. They point out that scientists have identified the mechanism underlying magnetoception in bacteria, but so far they've failed to identify such a mechanism with respect to more complex organisms like homing pigeons. According to the biologists, one of the principal reasons for the latter is the fact that magnetic fields penetrate just about anything, including biological tissue, with ease. "[This] means that magnetoreceptors, unlike most other sensory receptors, need not be located on an animal's surface and might instead be anywhere in the body," they explain.[4] The pair go on to suggest that magnetoception "might be accomplished by a small number of microscopic, possibly intracellular structures scattered throughout the body, with no obvious structure devoted to magnetoception."[5]

A further complication to consider is that it's not uncommon for particles of iron to accumulate in the bodies of organisms. For example, a high accumulation of iron in brain tissue is one of the features of Parkinson's disease. Therefore, what are thought to be magnetite

particles could in fact be particles of iron that have simply built up in the body and therefore have nothing to do with magnetoception. Distinguishing one from the other is no easy task, save for the fact that these mundane particles of iron are paramagnetic while magnetite is ferromagnetic. A ferromagnetic substance is one that exhibits strong magnetism. Paramagnetic substances are weakly attracted to a magnet, becoming slightly magnetized when exposed to a magnetic field, yet losing their magnetism when the field is removed.

Scientists have compared the situation to that of finding a needle in a haystack—or, in Lohmann and Johnsen's words, "finding a needle in a stack of needles."[6] Certainly mistakes have been made in the past. For example, at one point scientists were convinced they'd found magnetite-loaded cells in the beaks of homing pigeons, only to later discover that the so-called particles of magnetite were actually iron scavenged from red blood cells.

Rainbow trout

Although native to the lakes and rivers of North America, rainbow trout are a popular game fish and hence have been introduced to many other countries. During a 2012 trip to Tasmania's Great Lake, located in the northern region of the island, I was surprised to discover that even here there exists a population of rainbow trout; they were introduced into the Lake at the beginning of the 20th century. An attractive fish, they are generally blue-green or yellow-green in color, with dark spots on their backs and fins and a pink streak along either side.

In their native habitat, rainbow trout that have access to the ocean will sometimes adopt a migratory lifestyle. Abandoning their fresh water streams and rivers, they make their way down to estuarine areas and then into the ocean to feed and mature. In the process they acquire a slimmer profile as well as more silvery markings, transforming into what are called "steelheads." A steelhead is simply the oceangoing equivalent of a rainbow trout. Steelheads spend about three years in the ocean before returning to the freshwater streams and rivers of their birth in order to spawn.

In view of their (sometimes) migratory lifestyle, it's not surprising to learn that rainbow trout can sense the Earth's magnetic field. A leading researcher on magnetoception in rainbow trout is Michael Walker, a neuroscientist at the University of Auckland, New Zealand. In a 1997 study, Walker managed to detect electrical signals in the facial nerves of rainbow trout when the fish were exposed to magnetic fields. He also discovered in the nose of the trout what appeared to be magnetite-based magnetoreceptor cells. At the time, it remained impossible to determine for sure whether the cells were magnetoreceptors or not.

Fortunately, isolating individual magnetoreceptor cells is not the difficult challenge that it once was, thanks to a new technique developed by Stephan Eder of the University of Munich, Germany. This consists of examining cells under a microscope surrounded by a slowly rotating magnetic field. Cells that contain ferromagnetic iron, such as magnetite, "spin" under the influence of the magnetic field, and are therefore easy to spot, whereas cells that contain paramagnetic iron (or no iron) remain unaffected. In a study conducted in 2012, Eder's technique was applied to rainbow trout olfactory tissue, with the aim of isolating any magnetoreceptor cells that might exist within that tissue.

The tissue was carefully divided into separate cells. Each cell was placed in a Petri dish and analyzed individually. Fruitful results were obtained: about one out of every 10,000 cells "spun"—responded to the magnetic field. The cells that spun were found to contain crystals of magnetic iron—a substance extremely likely to be magnetite. "Our results show that the

magnetically identified cells clearly meet the physical requirements for a magnetoreceptor capable of rapidly detecting small changes in the external magnetic field," commented Eder and colleagues.[7]

Close inspection revealed that the crystals of magnetic iron were attached to the inside of the cell membrane. The former appear to function like miniature compass needles, staying aligned to the Earth's magnetic field. Presumably when the "needles" move, the cells to which they're attached move also, triggering electrical impulses that send direction-related information to the brain. Interestingly, it was discovered that each fish had an estimated 10 to 100 magnetoreceptor cells in its nose—which is clearly very few—but that the cells were far more magnetic than anticipated. Michael Winklhofer, who took part in the study, commented: "The cells are strongly magnetic, and if they are spaced too closely, they interfere with each other, which would deteriorate the sensitivity of the magnetic sense."[8]

According to an article published in *Discovery News*, the technique used by Eder to isolate magnetoreceptor cells in rainbow trout could also be used "to look for magnetic cells in animals that don't necessarily use a sense of magnetism but may have retained the cells even as evolution made them obsolete." The article continues: "Some recent research suggests that even people might harbor magnetic cells that linger from our ancestral hunter-gatherer days. If so, magnetic fields from power lines could be causing stress inside of our cells, leading to unknown health effects."[9]

Magnetic cows

As a teenager I lived on a rural property in the Northern Tablelands of New South Wales, a region dominated by rolling pastures populated with beef cattle like the cherry-red Santa Gertrudis. When driving past fields of grazing cattle, I couldn't help but notice that usually they all stood in the same direction. This struck me as exceedingly odd. I was eventually informed that the phenomenon is due to the direction of the wind—namely, that cattle have a tendency to stand with their backs against the wind so that it doesn't blow in their eyes. This explanation seems satisfying enough, but is it true?

In August 2008, there appeared online and in print a series of articles bearing such intriguing headlines as "'Magnetic Cows' are Visible from Space" and "Cows Have Strange Sixth Sense." The articles concerned a scientific study published that year in which a team of German and Czech researchers, headed by Dr. Sabine Begall, found compelling evidence of "magnetic alignment" in both grazing and resting cattle and deer.

For the cattle component of their study, the team used Google Earth satellite photos pertaining to 308 sites around the globe featuring 8,510 cattle, to determine in which direction the animals faced. The "bird's-eye" images clearly revealed that cattle tend to align themselves in a geomagnetic north-south direction, as though innately responding to the Earth's magnetic field. Both the direction of the wind and the angle of the Sun were ruled out as possible explanations for the finding. Additionally, the researchers carried out field observations, including measuring "deer beds" in snow, of 2,974 wild deer in 241 locations across the Czech Republic. As with cattle, the animals showed a clear preference for orienting themselves in a geomagnetic north-south direction.

If it's true that both cattle and deer possess magnetoception, wouldn't they respond not only to the Earth's magnetic field but also to artificial magnetic fields such as those generated by power lines? Using this question as the focus of their next study, the team examined Google

Earth satellite images of European cattle situated under or near high-voltage power lines, in addition to images of cattle situated well away from power lines. Whereas the familiar north-south orientation could be seen in the case of the "non-exposed" cattle, no such order was evident in the case of the "exposed" cattle—that is, body alignment was random. The same phenomenon was evident in the case of deer: deer situated near power lines were randomly aligned, while deer situated away from power lines were aligned north-south.

The results of the study strongly suggests that the extremely low frequency (ELF) magnetic fields that surround high-voltage power lines can disrupt magnetoception in both cattle and deer, consequently inhibiting their natural inclination to align with the Earth's magnetic field. Exactly as would be expected considering that magnetic fields decrease in intensity with distance from the source, the team observed that the "disturbing effect of the [ELF magnetic fields] on body alignment diminished with the distance from conductors."[10] In other words, the farther the animals were situated from power lines, the more natural—or north-south—was their body alignment.

What possible purpose would magnetoception serve in cattle and deer? One theory is that it aids in navigation as they move to fresh pastures. Another theory is that it synchronizes the direction of the herd and so improves their ability to escape predators and graze efficiently. Alternatively, Begall explains, "It could very well be that Earth's magnetic field has an effect on physiological processes—like brain waves or blood circulation—and that this magnetic alignment could make some bodily processes function better."[11]

If Begall's suggestion regarding bodily processes is correct, presumably both cattle and deer feel more comfortable, perhaps even sleep more soundly, when aligned north-south than when aligned differently. I know several people who insist they sleep best when their body is oriented in a particular compass direction. This belief is taken seriously in the traditional system of Indian medicine known as Ayurveda, whose roots go back some 3,000 years. According to one contemporary Ayurvedic source, you should never sleep with your head facing east as it can induce "disturbing dreams and restless sleep." Nor should you sleep with your head facing north as it "can be draining of energy." Sleeping with your head in the west, on the other hand, brings "meditative sleep and pleasant dreams." Sleeping with your head in the south "works with the polarity of the Earth to charge and heal your body."[12]

That the reasonably weak magnetic fields emitted by power lines can easily disrupt magnetoception in both cattle and deer is a disturbing finding. In what ways, if at all, are artificial EM fields affecting other animals endowed with magnetoception? Could this include human beings?

Since magnetite appears to be fundamental to magnetoception, the magnetic sense in both cattle and deer is presumably magnetite-related. Perhaps one day scientists will discover they harbor magnetoreceptor cells in their bodies similar to those isolated in rainbow trout.

Magnetite in the human body

In 1992, a geobiologist by the name of Dr. Joseph Kirschvink claimed to have found crystals of magnetite in human brain cells, publishing his findings in the journal *Proceedings of the National Academy of Sciences* (*PNAS*). At the time he made the claim, Kirschvink was employed with the California Institute of Technology, where, in the basement of the geology building, he had set up a special laboratory dedicated to biomagnetism research. In one early experiment, he and his scientist wife, Atsuko Kobayashi-Kirschvink, looked at magnetoception in honey bees,

the abdomens of which contain crystals of magnetite. They trained the bees to exit a maze in one particular direction. Then, with the use of a powerful magnetic field, they reversed the orientation of their magnetite crystals, causing the bees to fly in the opposite direction to which they'd been trained.

Kirschvink's decision to look for magnetite in human brain tissue was prompted by an interest in the controversial issue of whether artificial, non-ionizing EM fields—such as those emitted by power lines and household appliances—can cause cancer and other health problems. For in order to prove that such fields can induce biological effects in human beings, it would also have to be proven that the human body contains substances capable of responding to magnetic fields, such as magnetite.

For his study, Kirschvink used samples of fresh brain tissue taken from seven corpses, handling the samples with utmost care so as not to contaminate them with iron fragments from surgical tools or with magnetic dust particles. After the samples had first been frozen, they were placed in an extremely sensitive detector of magnetic fields (magnetometer) called a superconducting quantum interference device (SQUID). Detected in the samples by the SQUID magnetometer were ferromagnetic particles. Again, a ferromagnetic substance is one that exhibits strong magnetism; magnetite falls under this category.

The next task was to extract the magnetic particles from the samples. This involved dissolving the samples and placing them in special test tubes fitted with magnets. By the end of one week, magnetic particles had clung to the glass. The particles were examined using an electron microscope and identified as "minerals in the magnetite-maghemite family, with many of the crystal morphologies and structures resembling strongly those precipitated by magnetotactic bacteria and fish."[13] For most regions of the brain, the concentration of magnetite was relatively slight, at around 5 million crystals per gram. The meninges, the thin covering over the brain and spinal cord, had the highest concentration of magnetite, at 100 million crystals per gram.

Kirschvink, now of Princeton University, was extremely confident he'd found magnetite crystals in human brain cells, stating in a *New York Times* article that his discovery was "sure to astound most scientists." Later in the article he is quoted as saying that the National Institute of Health refused to finance his work in this area, "because they can't understand what a geologist is doing fooling around with human brain tissue."[14] Due to the controversial nature of his work, his paper was turned down by three leading research journals, including *Nature* (before being accepted by *PNAS*). And yet his competence as a scientist was, and is, unquestionable.

For reasons already discussed, attempts to find magnetite crystals in the bodies of animals have yielded less than convincing results. It was only very recently that scientists made a breakthrough in this area by using a microscope surrounded by a rotating magnetic field to isolate magnetite-loaded cells in rainbow trout olfactory tissue. If scientists were to apply this new technique to human brain tissue samples, it would settle once and for all the veracity or otherwise of Kirschvink's findings.

Discussing his research in 1992, Kirschvink opined that the crystals of magnetite believed to exist in the human brain, although unlikely to support any sensory capability in humans, might provide a means for EM fields to influence the human body. He explained, "Physicists and biophysicists have had trouble understanding how electromagnetic fields could affect human tissue until now, so what this discovery offers is another whole category of mechanisms that have not been considered."[15]

Aside from the brain, where else in the human body might magnetite exist? In 1983, a team of scientists at the University of Manchester, among them Dr. Robin Baker, claimed to have found deposits of ferric iron (most likely magnetite) in bones from the region of the sphenoid/ethmoid sinus complex of humans. The ethmoid bone, which sits in front of the sphenoid bone, is located at the roof of the nose, between the brain cavity and the nasal cavity. Passing through the ethmoid bone are olfactory nerves, which transmit messages from the nose to the brain.

Presumably referring to the University of Manchester study, the science journalist B. Blake Levitt states that the ethmoid bone "has a high concentration" of magnetite crystals.[16] She adds (without specifying her source) that crystals of magnetite have also been found in the blood-brain barrier (BBB). The BBB is a physiological mechanism whose function is to prevent certain substances in the blood from entering brain tissue while allowing other substances to enter freely.

Human homing pigeons

No scientist has conducted more research on human magnetoception than the aforementioned biologist Dr. Robin Baker. In the mid-1970s, while employed at the University of Manchester, Baker became intrigued by the possibility of a magnetic sense in human beings, and was curious to know how people would perform "when treated as homing pigeons."[17]

For his first series of experiments, which began in 1976, third-year zoology students from the University of Manchester were blindfolded and taken on van trips over complex and winding routes, ranging in distance from 6 to 52 km from the University, to destinations unfamiliar to them.

The students, still blindfolded, were individually led off the van and asked to perform a series of tasks. First, they had to state the direction they thought they were facing in relation to the University (north, west, etc.) They then had to point toward the University. Then, with blind fold removed, they again had to point toward the University. Surprisingly, the students had a better idea of where they were with the blindfold on—often being highly accurate with their estimates of "home" direction—than with the blindfold removed, which frequently made them disorientated. It became apparent to Baker that "somehow the students had managed while blindfolded to follow the twists and turns of the outward journey and maintain an awareness of the direction of home…"[18] Yet with the blindfold removed and their surroundings clearly visible, they became confused.

Dr. Robin Baker. Photo courtesy of Elizabeth Oram, Wikimedia Commons.

To see if the students had really made use of a magnetic sense, Baker thoroughly investigated all possible alternative explanations. Since the students performed just as well in the experiment regardless of whether it was sunny or overcast, and since placing curtains over the windows of the van also made no difference, this ruled out the possibility that some of them had managed to keep track of which way the van was travelling by feeling the heat of the sun on their faces. Nor was distance travelled found to affect performance. The students were just as accurate in their ability to estimate home direction when the distance travelled was far as when the distance travelled was short. Baker stated, "Nothing I could test seemed to influence the students' performance."[19]

Baker had heard of an experiment performed in Germany in which homing pigeons exposed to an artificial magnetic field prior to being released were observed to take off in a different direction to homing pigeons exposed to the Earth's magnetic field only. The former had difficulty finding their way home, becoming completely disoriented; the latter did not. The experiment demonstrated that homing pigeons use the Earth's magnetic field to follow their outward journey. If, reasoned Baker, human beings are able to make use of the Earth's magnetic field in the same way, a bar magnet attached to the head of the subject ought to be enough to disrupt the ability.

In one of Baker's best-known experiments, a group of high school students from two schools in Barnard Castle, County Durham, were transported on a bus to two unknown locations. All of the students were blindfolded and wore bar magnets on their heads. However, although the students were under the impression that they were all wearing real magnets, half of them were actually wearing dummy magnets—brass bars of the same size and shape. Since the weather was cloudy and rainy, there was no way for the students to sense the warmth or position of the sun. When the bus had arrived at its first destination, the students, while remaining blindfolded, were told to write down their compass direction from school. The same procedure was carried out at the second destination.

Overall, the students who wore dummy magnets performed well in the experiment—they had a good sense of which way was home—while the students who wore real magnets performed poorly. Interestingly, at the first location the latter group gave estimates of home direction that were "consistently nearly 90° anticlockwise of the true direction," yet by the time they reached the second location they had become disorientated to the point where their estimates were completely off.[20] According to Baker, "It really did seem as though the wearing of magnets had disrupted the ability to orientate during blindfold displacement."[21] In subsequent experiments of this kind, subjects wore not bar magnets but specially constructed PVC helmets fitted with Helmholtz coils powered by a 9 volt battery, enabling the experimenters to more accurately control the magnetic field passing through the subject's head.

"Chair" and "walkabout" experiments

Baker's exploration of human magnetoception encompassed not only "bus" but also "chair" and "walkabout" experiments. In his "chair" experiments, most of which were carried out in a wooden hut in rural Gloucestershire, subjects were fitted with a blindfold and earmuffs and made to sit in a rotating wooden chair. After being rotated one way then the other way, the subject was brought to a stop and asked to estimate their compass direction. This was repeated another eight times. As in the case of his "bus" experiments, there was a noticeable difference in performance between subjects exposed to the Earth's magnetic field only and subjects exposed to the altered magnetic field of a bar magnet.

Placing blindfolded subjects on buses and in rotating chairs is hardly the most natural approach to testing magnetoception in humans. What about the use of magnetoception in everyday situations, such as when exploring an area you've never visited before? It was this question that prompted Baker to devise his "walkabout" style of experiment.

In one such experiment, Baker, together with his colleague Janice G. Mather, took a group of 37 zoology students to an unfamiliar, wooded location in Woodchester Park, Gloucestershire. Although blindfolds didn't feature in the experiment—the students were able to see—helmets did. Some of them wore activated helmets (the magnetic field switched on); others wore deactivated helmets (the magnetic field switched off). All believed the helmets to be activated. The students were taken on a roughly 500 meter hike along a twisting path through unbroken woodland, the sun barely poking through the dense foliage. According to Baker, some "highly significant differences emerged between those wearing activated helmets and those wearing deactivated helmets, both with respect to the compass direction they thought they had travelled and with respect to their ability to point back to their starting position."[22] Commenting on the significance of the experiment, Baker suggests that "as we move around our environment we make unknowing use of a magnetic sense."[23]

Controversy

Taken as a whole, the results of Baker's human magnetoception studies are very persuasive, leaving us, in his words, with "no alternative but to take seriously the possibility that Man has a magnetic sense of direction."[24] Baker views human magnetoception as an innate subconscious sense whose origins date back to the hunter-gatherer era, an era when survival depended on our ability to find our way from place to place in search of food without becoming lost; and while we no longer rely on this sense to the extent we once did, it still plays a role in our everyday lives.

Baker's assertion that humans possess a magnetic sense similar to that of other animals was seen by many scientists as identical to supporting the idea of telepathy or some other psychic faculty. Both phenomena, after all, constitute a "sixth sense," never mind the fact that one is slightly less extraordinary than the other. And since, in the words of Carl Sagan, "extraordinary claims require extraordinary evidence," Baker's findings regarding human magnetoception were subjected to an extensive amount of scientific nitpicking. Attempts were made to replicate his results, several of which failed.

In 1981, an American team by the names of Gould and Able made eight attempts to repeat Baker's famous "bus" experiment, using as subjects undergraduates and staff from Princeton and Albany. All eight attempts were unsuccessful, forcing the pair to conclude that Baker's students "either had cues available to them which were absent in our experiments, or are dramatically better than Americans in using whatever cues may be involved in judging displacement."[25] To account for Gould and Able's replication failure, Baker uncovered evidence showing that their experiments had coincided with geomagnetic disturbances, his argument being that these disturbances had prevented the participants from accurately sensing the Earth's magnetic field—as is known to happen to homing pigeons.

A duo from the University of Sheffield, England, also tried to replicate Baker's findings, conducting between 1980 and 1983 a total of four "bus" experiments using Sheffield psychology students as participants. Despite having made allowances for geomagnetic influences, the results obtained by the pair "fail[ed] to provide any support for blindfold navigation in humans…" They added, displaying a hint of bias, "It is obviously extremely difficult to counter all conceivable explanations for a negative result but we are forced to wonder about the ecological importance of a magnetic sense, the existence of which is so difficult to demonstrate."[26]

Eventually Baker's findings were entirely rejected, and the consensus among scientists today is that humans do not possess a magnetic sense. Disappointed, Baker ceased his research in magnetoception and went on to study "sperm competition" among humans, writing a best-selling book on the subject titled *Sperm Wars*. He now resides in Spain with his family. In a recent interview with British science journalist Ed Yong, Baker had this to say about his pioneer research in human magnetoception:

> "I'd spent nearly a decade, tested thousands of people under all sorts of conditions, and had absolutely no doubt [as to the reality of the phenomenon]. Then people did a few tests here and there and claimed the experiments didn't replicate. Even after I'd collected everybody else's results and published that taken together, [which showed that] they did in fact constitute successful replication, nobody wanted to know."[27]

It would be unfair and narrow-minded to reject Baker's evidence of a magnetic sense in human beings on the grounds that a handful of researchers failed to replicate his results. That this sense operates on a subconscious level and is also very weak makes it extremely difficult to study, much less prove to the satisfaction of the skeptical scientific establishment. Magnetoception is a challenge to study even in animals known to make explicit use of this ability. We are dealing with a sense so subtle it can easily be disrupted by a bar magnet strapped to the head or by a geomagnetic disturbance. And let's not forget that the modern world is absolutely permeated with artificial EM fields, potentially causing further disruptive effects.

■■■

At the end of the day, Baker's studies failed to yield the shiny, clearcut results that mainstream, mechanistic science values so highly. That the topic of human magnetoception has always been considered controversial didn't help matters. Fortunately, however, scientists are starting to take another look at the possibility of a magnetic sense in human beings, thanks to the common fruit fly and a protein called cryptochrome, which we will discuss in the next chapter.

2 The Electromagnetic Pulse of Life

In the previous chapter we established that magnetoception exists in a wide variety of life forms. We saw that even cattle and deer appear to possess this ability, as shown by their tendency to line up parallel to the Earth's magnetic field (except when in close proximity to high-voltage power lines). In this chapter we will further investigate the possibility of magnetoception in humans. We will also take a look at the related issue of whether geomagnetic disturbances are capable of affecting the human body. But first let us turn our attention to birds.

The radical–pair mechanism

That many species of bird make use of the Earth's magnetic field for navigational purposes is confirmed beyond all doubt. What remains unclear is the mechanism behind this ability. There are two models as to how avian magnetoception functions. One model, which we touched on earlier, views the phenomenon as magnetite-based. The other involves a radical pair. Central to the radical pair theory is a class of light-sensitive proteins called cryptochromes, which regulate circadian rhythms in plants and animals.

Before we discuss the radical pair theory, it's necessary to know a little about molecules. A molecule consists of two or more atoms held together by chemical bonds. For example, a water molecule is made up of two hydrogen atoms bonded covalently to a single oxygen atom—hence the chemical symbol H_2O. A covalent bond results from the sharing of an electron pair between two atoms.

Electrons possess a property called "spin," whereby they "revolve" around their own axis in either a clockwise or counterclockwise direction. Furthermore, the electrons within an atom or molecule like to spin in pairs. Such a pair will form if the two electrons occupy the same orbital. Paired electrons balance each other out by spinning in opposite directions. A water molecule has all of its electrons paired; for every electron spinning clockwise there is another electron spinning counterclockwise.

A radical (or free radical) is a molecule that contains at least one unpaired electron and is therefore unstable and highly reactive. As an example, let's take the hydroxyl radical (chemical symbol HO). Whereas a water molecule has a total of 10 electrons, and is therefore stable, a hydroxyl radical has nine electrons; one of its electrons is unpaired. In an effort to achieve stability, a radical will "steal" an electron from another molecule. The molecule from which it has stolen an electron can become a radical itself, which can then steal an electron from another molecule, and so on, resulting in a chain reaction.

There is a phenomenon in quantum mechanics called entanglement—what Einstein referred to as "spooky action at a distance." This occurs when pairs of particles—a pair of photons, for example—interact and then become separated. (Photons are the building blocks of electromagnetic radiation.) The moment the direction of spin of photon A is measured, its entangled partner, photon B, will instantly adopt an opposite spin to photon A. It's as though the

particles are linked by an invisible thread, so that each knows what the other is doing. While, theoretically, entanglement is independent of distance, the furthest distance confirmed to date is 89 miles, between La Palma and Tenerife, two of Spain's Canary Islands. Physicists are planning to top this record by testing entanglement between a location on the ground and the International Space Station, which orbits the Earth at a distance of around 250 miles. It should be mentioned in passing that the speed of "communication" between entangled particles isn't necessarily instantaneous; all that's been confirmed so far is that it's *at least* 10,000 times the speed of light.

By imagining a pair of hypothetical entangled dice, the concept of quantum entanglement is easier to grasp. Being entangled, the pair of dice will always land on matching numbers. This would hold true even if you flung the dice high into the air so that they landed miles apart (as opposed to rolling them on the table in front of you). Interestingly, quantum theory declares that until one of the die is actually observed, both dice exist in all possible states simultaneously. (In this instance, all possible states include the numbers one through six.)

The radical pair theory of avian magnetoception states that when a photon strikes the avian retina a pair of radicals is produced, and that their unpaired electrons become entangled. Although the two radicals are eager to combine to form a more stable molecule, they cannot do so unless their respective unpaired electrons are spinning in opposite directions; if spinning in the same direction, one of the electrons must reverse its spin. Magnetic fields can act on the electrons by making them spin in either direction, which in turn affects the time it takes for the two radicals to combine.

For the radical pair theory to hold water, there would have to be something in the cells of the avian retina that can produce a pair of radicals in response to being struck by light. And in fact there is: the molecule cryptochrome. Given that cryptochrome affects the light sensitivity of retinal cells, presumably so do magnetic fields. The inference is that birds literally see magnetic fields. Presumably, these take the form of patterns of light and shade superimposed on top of what the bird normally sees, the patterns changing as it turns and tilts its head.

Plenty of evidence indicates, as per the radical pair theory, that cryptochrome plays a fundamental role in avian magnetoception. For example, studies have shown that for a number of species of bird, magnetoception depends on the presence of light—specifically, light from the blue-green end of the spectrum. This makes sense in view of the fact that cryptochromes are blue-light sensitive.

Birds wearing goggles

To what extend are birds dependent on vision when it comes to using the Earth's magnetic field to navigate? In a 2010 study conducted by Katrin Stapput of Goethe University, in Germany, European robins were fitted with goggles that had clear foil on one side and frosted foil on the other. Although both types of foil were light penetrable, the frosted foil gave a murky image. When it came time for the birds to migrate, they were placed in funnel-shaped cages lined with correction fluid; scratches left in the correction fluid showed in which directions the birds tried to set off. Birds wearing goggles with frosted foil covering the left eye (and clear foil on the right) tried to set off in the proper northerly direction, as did birds not wearing goggles. On the contrary, birds wearing goggles with frosted foil covering the right eye (and clear foil on the left) became completely disorientated.

The study supports the notion that birds perceive magnetic fields in the form of patterns of light and shade superimposed on top of what they normally see, thus virtually confirming the

radical pair theory. If birds relied solely on light to perceive magnetic fields, the goggles wouldn't have affected them. Since the goggles did affect them, the phenomenon obviously depends not only on light but clarity of vision. That the robins became disorientated only when the right eye was covered confirmed what earlier studies had shown: robins and many other species of migratory bird perceive magnetic fields solely using the right eye; the left eye is not involved.

A map and compass system

Long distance navigation of the kind performed by migratory birds would depend on having access to both an internal compass and an internal map. The radical pair theory accounts for the former (the compass) yet fails to account for the latter (the map). Let's say you're abducted from your home by a group of thugs who throw you into the back of a car and drive you blindfolded to an unfamiliar location in the middle of the desert. After kicking you out of the car, they speed off. You immediately remember that your watch has a compass. Sure, the compass would tell you which way is north, and so on, but it wouldn't tell you which way is home. For that you would need a map.

Loggerhead sea turtles possess, in addition to a magnetic compass, an inherited magnetic map. But what about migratory birds? Researchers have suggested that as birds fly around they use magnetite-based magnetoreceptors in their beaks to sense variations in magnetic field intensity—magnetic field intensity differs from place to place—and in the process construct a mental map of the Earth's magnetic field. Birds, then, appear to be equipped with a radical pair-based sense that serves the role of a compass and enables the bird to see magnetic fields, and a magnetite-based sense that serves the role of a map and involves the beak. Mind you, while evidence is growing in support of the former, the latter remains held back by the fact that scientists haven't yet managed to positively identify magnetite-based magnetoreceptors in the beaks of migratory birds. It would be premature to declare that the mystery of avian navigation has been solved. If anything, the recent introduction of the radical pair theory, and all this talk of entangled electrons, has only deepened the mystery.

A magnetic sense in plants

If cryptochromes play a role in magnetic sensing in birds, could they also play a role in magnetic sensing in plants?

Crytochromes are one of the three major types of photoreceptor (light-sensitive) proteins in plants. The remaining two are phototro-pins, which are blue light-sensitive, and phytochromes, which are red light-sensitive. These three types of photoreceptors, by sensing and responding to light, regulate growth, metabolism, and physiological development in plants. Thus, altering the lighting conditions to which a plant is exposed, especially with respect to both red and blue light, can dramatically affect its growth and wellbeing.

Thale cress (*Arabidopsis thaliana*), a small flowering plant native to Europe and America, is the lab rat of the plant world; the simplicity of its genome makes it a popular choice in genetic research. It's been discovered that in thale cress the cryptochrome genes *Cry1* and *Cry2* mediate several responses that depend on blue light, including inhibiting growth of the hypocotyl (the embryonic stem).

In a 2006 study to see if magnetic fields can influence cryptochrome function in plants,

biologist Margaret Ahmad of the National Center for Scientific Research, in Paris, raised thale cress seedlings in a magnetic field of 500 μT (microtesla) while under blue light. Blue light was used to ensure that cryptochromes were the mediating photoreceptors (since cryptochromes are blue-light sensitive). The seedlings were found to have shorter stems (enhanced hypocotyl growth inhibition) compared to control seedlings raised in the natural magnetic field of the Earth. In contrast, there was no sign of stem length reduction (enhanced hypocotyl growth inhibition) in the case of seedlings grown under red light (with phytochromes as the mediating photoreceptors), nor in the case of seedlings grown in total darkness. Furthermore, mutant plants lacking cryptochromes were found to be unaffected by variations in magnetic field intensity. "These findings show that higher plants are sensitive to the magnetic field in responses that are linked to cryptochrome-dependent signaling pathways," Ahmad and colleagues concluded. "[O]ur results can best be explained by the radical-pair model."[1]

Not only does Ahmad's study constitute compelling evidence that cryptochromes function in magnetoception, it suggest that plants—and by extension animals, since cryptochromes exists in both plants and animals—can be adversely affected by artificial magnetic fields, acting via the radical pair mechanism. Could her study explain the many reports of high voltage power lines and their ELF magnetic fields causing nearby foliage to sicken and die?

Fruit flies and cryptochrome

An important point to consider in Ahmad's study is that the thale cress seedlings responded to an artificial magnetic field only when grown under blue light. This is because cryptochrome, to which thale cress owes its magnetic sense, requires blue light to become "active"; if deprived of blue light it remains "inactive." Similarly, research has shown that fruit flies (*Drosophila*) depend on both cryptochrome and blue light to sense magnetic fields.

In a 2008 study led by neuroscientist Steven Reppert of the University of Massachusetts Medical School, magnetic sensing was tested in both regular fruit flies and cryptochrome-deficient fruit flies. The cry-deficient flies had been genetically modified to lack cryptochrome, whereas the regular flies were unaltered.

The regular flies were placed in a T-shaped maze. One arm of the maze was bathed in a magnetic field and contained a sugar reward; the other arm had no sugar reward and no magnetic field. Both arms were exposed to blue light. Before long, the flies had learned to associate a magnetic field with a reward of sugar—that is, they developed a preference for the "magnetized arm." When the procedure was repeated in the absence of blue light, the flies exhibited no preference for either arm; their magnetic sense had been rendered dysfunctional. In contrast, the cry-deficient flies showed no response to a magnetic field, even when blue light was present, and hence could not be trained to associate a magnetic field with a reward of sugar. Although the study doesn't prove that cryptochrome is the magnetic field receptor in fruit flies, it does show that cryptochrome is essential for magnetoception in fruit flies.

Having established that cry-deficient flies are unable to sense a magnetic field, Reppert, in collaboration with Lauren E. Foley and Robert J. Gegear, decided to take matters a step further, by seeing what would happen if human cryptochrome—for the human retina is loaded with cryptochrome—is inserted into cry-deficient fruit flies. The scientists genetically modified fruit flies to exhibit hCRY2, the human version of cryptochrome, in place of their own version of cryptochrome. They then tested the mutant hCRY2 flies in the same T-shaped maze used in the earlier study. Like regular flies, they learned to respond to an artificial magnetic field, while

depriving them of blue light inhibited their magnetic sense. The study, published in 2011 in the journal *Nature Communications*, demonstrated that hCRY2 "can function as a magnetosensor in the magnetoreception system of *Drosophila* and that it does so in a light-dependent manner."[2] The scientists add: "[A] reassessment of human magnetosensitivity may be in order."[3]

So we know that human cryptochrome can act as a magnetic sensor, on account of its ability to restore magnetoception in cry-deficient fruit flies. But does this prove the reality of human magnetoception? Unfortunately the answer is no. According to biologist Roswitha Wiltschko of Goethe University in Frankfurt, Germany, "To sense the magnetic field, one does not only need a molecule like cryptochrome, but also an apparatus that picks up the changes in that molecule and mediates it to the brain. *Drosophila* obviously has this apparatus, but humans? I have my doubts."[4] Reppert added that the hCRY2 in the human retina is "beautifully poised to sense light," but that "we don't know if it has the downstream pathways that communicate magnetic information to the brain. The possibility exists."[5]

Whereas Wiltschko and numerous other scientists are skeptical that humans possess a cryptochrome-based magnetic sense, Reppert is very much open to the possibility. He says we might be using our eyes to sense magnetic fields without being aware of it. "I would be very surprised if we don't have this sense," he commented. "[I]t's used in a variety of other animals. I think that the issue is to figure out how we use it."[6] He added: "[Cryptochrome] is thought to be very important for how animals migrate. Perhaps this protein is also fulfilling an important function for sensing magnetic fields in humans. It may aid how animals perceive how objects are in time and space in a way we haven't thought about before."[7]

Speculations

If, as Reppert suggested, we use our eyes to sense magnetic fields without being aware of it, it would explain the apparent success of Robin Baker's experiments in human magnetoception. As you will recall regarding the "bus" series of experiments, the participants performed reasonably well while blindfolded yet became disoriented the moment their blindfolds were removed, indicating that human magnetoception functions on a subconscious level.

But since the radical pair mechanism is light-dependent, wouldn't depriving your eyes of light by wearing a blindfold deactivate your magnetic sense? If avian magnetoception depends on the presence of light, why shouldn't human magnetoception?

Allow me to address this matter by first explaining that birds require very little light to utilize their magnetic sense; robins, for example, can migrate at night. Secondly, it's not so much crucial that they receive light, but that they receive light from the blue-green end of the spectrum. The bottom line is that cryptochrome—and hence the radical pair mechanism—is blue-light sensitive. I very much doubt that the blindfolds worn by the participants in Baker's experiments were so effective they blocked out all light. Most blindfolds permit a tiny bit of light to enter around the edges—certainly enough to activate the radical pair mechanism.

I wonder if the best way to study magnetoception in humans is to fit participants with goggles similar to the ones fitted to robins in Katrin Stapput's study, although with frosted foil on both sides. The goggles would provide plenty of light to the eyes yet at the same time prevent the wearer from viewing their surroundings. The irony of this suggestion is that in Stapput's study, such goggles were found to inhibit magnetoception in robins, by preventing them from seeing the Earth's magnetic field. In their case this faculty depends on clear vision. We, on the other hand, seem to be using our eyes to sense magnetic fields in some fashion that does not

involve actually seeing them—and hence is independent of clear vision.

This is not to rule out the possibility that some people can see magnetic fields. Perhaps those who claim to be able to see "auras"—fields of subtle, luminous radiation surrounding living and non-living things—are actually gifted with magnetic sight similar to that possessed by a bird. Or, rather, perhaps they are people in whom the faculty of visual magnetoception is fully awakened, the rest of the population being unable to use this faculty at its full capacity.

Another possibility to consider is that our distant ancestors possessed this faculty but modern humans do not, the faculty having vanished at some point during our evolution. Our ancestors, being nomadic, survived by journeying from place to place in search of food, and no doubt would have benefited greatly from the ability to navigate via the Earth's magnetic field. It's not unreasonable to assume that the emergence of civilization rendered this faculty redundant, so that it gradually weakened before vanishing altogether. This would mean that the cryptochrome in our eyes once functioned as a magnetic sensor yet does not serve this function today.

Cryptochromes and circadian rhythms

We've already looked at cryptochromes in relation to the radical pair mechanism. It is time we examined cryptochromes in relation to circadian rhythms. Circadian rhythms are patterns of biological activity and rest attuned to the 24-hour day. (The term *circadian* consists of the Latin words *circa*, meaning "approximately," and *diem*, meaning "day.") They are seen in virtually all plants and animals, even in fungi and blue-green algae. Yet it is the circadian rhythms of humans that concern us in this chapter.

Although our circadian rhythms are endogenous (self-sustaining), they adjust (entrain) to the local environment by responding to the light-dark cycle. This is especially true of the sleep-wake cycle, which governs the fact that each day you sleep for approximately eight hours and are awake for 16. A less noticeable circadian rhythm is that of core body temperature (CBT). If you were to monitor your CBT throughout an entire day, you would find that it peaks in the late-afternoon (reaching around 98.8°F) and troughs in the early morning (to around 98.06°F). This minor fluctuation in temperature partly explains why, during the early morning, you sometimes find yourself reaching for that extra blanket at the end of your bed. Other important bodily functions in which circadian rhythms play a role include blood pressure, urine production, digestion, respiration, alertness, appetite, and hormone secretion.

Our circadian rhythms are controlled by biological clocks, which consist of groupings of interacting molecules in cells throughout our body. These body clocks are in turn controlled by a "master clock" called the suprachiasmatic nucleus (SCN). The SCN is located in a region of the brain called the hypothalamus, which is the main control center for the autonomic nervous system (ANS). To simplify matters, it helps to think of the SCN as the body's only biological clock. In summary, then, each human being has a biological clock that controls their circadian rhythms.

I'll never forget the analogue clock situated above the blackboard of our classroom in second grade, a bulky, metal-rimmed contraption that looked as though it had been built in the 1970s. Because it had a tendency to skip ahead, every week our teacher would dismount it from the wall and adjust it accordingly. The biological clock that drives your circadian rhythms is similar in the sense that it, too, fails to keep perfect time, and so must be adjusted, or reset, periodically.

What serves to reset our biological clock each day, so that our circadian rhythms remain

attuned to the local environment, is of course, light. Consider for example the sleep-wake cycle. When you turn off your light and climb into bed at the end of the day, the SCN tells the pineal gland, a tiny endocrine organ situated at the center of the brain, to increase its production of the hormone melatonin. Melatonin promotes sleep by decreasing body temperature and respiration rate. Whereas darkness triggers the production of melatonin, light inhibits the production of melatonin. The moment morning arrives and light is detected by the retina, the SCN tells the pineal gland to lower its production of melatonin. Soon all traces of sleepiness vanish and you're ready to take on a new day.

Studies have revealed that the most important form of light involved in resetting the biological clock is blue light. An environmental cue that helps to reset an organism's biological clock is called a zeitgeber (meaning "time-giver" in German). Light, then, is a zeitgeber, and clearly a very important one. Another zeitgeber is the Earth's magnetic field, "which changes on a 24-hour cycle as the Earth turns on its axis."[8] We'll consider this particular zeitgeber later.

Experiments have shown that if a person is kept in prolonged isolation from the light-dark cycle and other external factors, such as by living in a cave or underground bunker for a period of many months, their circadian rhythms eventually drift entirely out of phase with the outside world—that is, become "free running." This is because their biological clock cannot reset itself in response to the light-dark cycle. It's the same as if my teacher had failed to adjust the clock every week. Without these continual adjustments, it wouldn't have taken long for the clock to have fallen completely out of phase with "real time."

Anyone who has travelled abruptly across numerous time zones, such as by taking a flight from New York to London, and arrived at their destination feeling fatigued, disorientated, unable to concentrate, sick in the stomach, and so on, would know that these are all symptoms of jet lag. Jet lag is due to a disruption of your circadian rhythms. When you hop off the plane at London's Heathrow Airport, it might be 7 p.m., the sun having set several hours ago; your body, on the other hand, thinks it is 2 p.m. New York time. The symptoms of jet lag disappear as soon as your circadian rhythms adjust to the new time zone.

Cryptochrome or melanopsin?

The master clock (SCN) in the hypothalamus is aware of how much light is present in the environment by receiving signals from special photoreceptor cells in the retina. These signals are transmitted to the SCN via neurons of the retinohypothalamic tract (RHT). The SCN uses this information to keep track of the time of day and in so doing it controls our circadian rhythms. The photoreceptor cells referred to here are neither rods nor cones. Both rods and cones, which are located on the outer layer of the retina, are essential for vision, yet neither is involved in circadian photoreception. (Cone cells are responsible for perceiving color and fine detail, whereas rod cells are responsible for perceiving the size, shape, and brightness of visual images.)

The inner layer of the retina contains what are known as ganglion cells, a very small portion of which are intrinsically photosensitive. It is these intrinsically photosensitive retinal ganglion cells (ipRGCs) that send signals to the SCN concerning how much light is present in the environment. But to what do they owe their photosensitivity? Two possibilities have been suggested: cryptochrome and melanopsin. Although it appears that both cryptochrome and melanopsin are involved in circadian photoreception, which of the two is the *main* circadian photoreceptor has yet to be determined. It's noteworthy that cryptochrome has been found in the inner layer of the retina, where ganglion cells are located. Comparably noteworthy is that

melanopsin has been found in ipRGCs and, like cryptochrome, is sensitive to blue light. To discuss the fine details of the "cryptochrome versus melanopsin debate" is beyond the scope of this book.

The mysterious pineal gland

So far we've looked at two possible mechanisms by which humans might be able to sense magnetic fields: a magnetite-based mechanism and a radical pair mechanism. Perhaps as appears to be the case with migratory birds, humans are equipped with both mechanisms. In a moment we'll take a look at evidence showing that the pineal gland is sensitive to magnetic fields.

The pineal gland is one of the seven major glands that together comprise the endocrine system. By secreting chemical substances called hormones directly into the bloodstream, the endocrine glands regulate a number of important processes within the body, including metabolism, growth and development, sexual function, tissue function, mood, and sleep.

The pineal gland is located between the two cerebral hemispheres of the brain, beneath the back part of the corpus callosum. It's about the size of a grain of rice and similar in shape to a pine cone. (The Latin word *pinea* means "pine cone.") It begins to shrink with the onset of puberty and is therefore larger in children than in adults. Modern imaging techniques like X-ray have revealed that in most people the pineal gland has undergone some degree of calcification. (Calcification is where the tissue accumulates calcium salts, causing it to harden.)

Scientists have long been baffled by the pineal gland, which is astutely described by *Encyclopedia Britannica* as "the most enigmatic of endocrine organs."[9] Several thousand years ago it was believed to control the flow of memories into consciousness. The 17th-century French philosopher-mathematician Rene Descartes (1596–1650), whose experiments in physiology included cutting up living dogs so as to study their hearts, thoroughly plumbed the pineal gland and attributed to it metaphysical properties. Having observed that the pineal gland is the only non-double organ in the brain, he came to regard it as the "seat of the soul," the point where the mind and body unite.

Melatonin and health

Proper melatonin production by the pineal gland is essential for maintaining a normal sleep-wake cycle. It also helps strengthen the immune system. An abundance of research suggests that abnormal melatonin levels, especially a deficiency in melatonin, can result in numerous health problems, both physical and mental, including cancer, Alzheimer's disease, diabetes, heart disease, depression, schizophrenia, and bipolar disorder. The connection between melatonin deficiency and cancer is especially worrying. "Some recent research has suggested that low melatonin levels in the body may be linked to a higher risk of certain types of cancer," states the American Cancer Society.[10] Also, "Melatonin has been shown to slow or stop the growth of several types of cancer cells when studied in the laboratory."[11]

Melatonin acts as an extremely powerful antioxidant, or "free radical scavenger," and thus has an anti-ageing effect. As explained, radicals are molecules that contain at least one unpaired electron and hence are unstable and highly reactive. In the human body, radicals are formed naturally, for instance, during metabolism, as well as unnaturally, such as due to exposure from pollution in the environment. Because they "attack" the molecules of our cells, radicals have a destructive effect on the body and are thought to contribute to the process of aging. Actually, not

all radicals are harmful; sometimes the immune system purposely creates them to neutralize viruses and bacteria. The problem is when radical production becomes excessive. This is where antioxidants like melatonin come into the picture. Antioxidants neutralize radicals, putting a stop to their destructive chain reactions, by donating one of their electrons.

"Melatonin production gradually decreases with age, and its loss is associated with severe age-related diseases," states the *Encyclopedia Britannica*.[12] The American Healer and psychic Edgar Cayce (1877–1945), seemingly intuitively aware that the pineal gland produces a hormone with anti-aging properties, is alleged to have stated: "Keep the pineal gland operating and you won't grow old; you will always be young!"[13] (Melatonin wasn't discovered until 1958—more than a decade after Cayce passed away.)

The third eye

In certain Hindu and Tantric Buddhist traditions, mention is made of various psychic-energy centers of the body, called chakras. (*Chakra* means "wheel.") One source describes them as "focal points where psychic forces and bodily functions merge with and interact with each other."[14] There are popularly thought to be seven major chakras of the body and each is associated with a specific color, sense organ, deity, mantra, and so on. In diagrams, the chakras are shown to be located along the middle of the body, with the "lowest" chakra at the base of the spine and the "highest" chakra just above the crown of the skull. Remarkably, each of the seven major chakras corresponds almost precisely in terms of placement with one of the seven major organs of the endocrine system. The sixth chakra, or crown chakra—also known as the "third eye," owing to its location in the middle of the forehead—is generally associated with the pineal gland.

Shiva, one of the major deities of Hinduism, possesses a third eye with which he is endowed with inward vision. He can also use his third eye to annihilate evil by projecting from it a beam of fire. The third eye of Shiva symbolizes spiritual power and great wisdom—qualities that come with the activation of the crown chakra. Apparently, to have opened or gained access to the third eye is to have achieved a state of higher consciousness, even enlightenment itself.

In New Age and occult literature, the third eye is often equated with the supposed sixth sense; or, more generally, with the ability to perceive or experience phenomena that exists beyond the physical realm. According to Barbara Hand Clow, a prolific author of books on astrology and other spiritual topics, "With the third eye we can locate ourselves in nonsolid realms—other dimensions such as the 'dream-time,' where we can travel into times and places outside of our ordinary reality."[15] Of course, whether we literally possess a spiritual third eye is very much open to contention. What's important to recognize here is the association between it and the pineal gland.

The term *third eye* as used in a scientific context has nothing to do with chakras or psychic powers; rather, it refers to the parietal eye, which is closely related to the pineal gland. The parietal eye is a light-sensitive spot on the top of the head of some reptiles, amphibians, and other lower vertebrates. It is thought to be a vestigial organ—what remains of an actual third eye. It is not present in birds and mammals, which instead have a pineal gland. In the New Zealand tuatara, a large and ancient lizard-like reptile, the parietal eye is so pronounced as to feature a rudimentary lens. Yet rather than being an organ of vision, its purpose is to register the light-dark cycle for hormone regulation. When you consider animals like the tuatara, with its strange,

vestigial third eye, it's easy to imagine how, during the process of evolution, the "third eye of old" gradually receded into the skull to become what today is the pineal gland.

Dimethyltryptamine (DMT)

In addition to producing the hormone melatonin, the pineal gland contains a high concentration of the neurotransmitter serotonin. Serotonin is known to play a key role in regulating mood, with low levels of serotonin contributing to depression and high levels of serotonin contributing to happiness. Furthermore, there is some evidence that the hallucinogenic compound Dimethyltryptamine (DMT) is produced in the pineal gland. DMT is structurally related to the hallucinogenic drug LSD (lysergic acid diethylamide) and, like LSD, blocks the action of serotonin in brain tissue. As well as being present in numerous plant species, DMT exists in trace amounts in humans and other mammals, yet its function with regard to the latter remains unknown.

Ayahuasca is a DMT-containing hallucinogenic brew that is traditionally used by the Indians of the Amazon basin for shamanistic purposes, who cite clairvoyance and contact with spirits as two of its remarkable effects. It is popular among spiritual seekers in the United States and other Western countries, and has been promoted as a "medicine for the soul" by the musician and actor Ben Lee and other celebrities. Brown in color and said to taste bitter and unpleasant, it's produced from a boiled-down mixture of the banisteriopsis caapi vine and other plants.

Although I can't say I've tried ayahuasca, nor would I want to on account of its more hazardous aspects, I admit to being deeply intrigued by the experiences of those who have. As recounted in his memoir *Broken Music*, the musician Sting took ayahuasca under the guidance of a traditional shaman during a tour of Latin America in 1987. He recalls of his ayahuasca trip: "Closing your eyes transports you to this other world, as real as any other, where sound becomes light and light becomes color and color turns into geometry… I am either dreaming awake or I am dead."[16]

The theory that DMT is produced in the pineal gland can be attributed largely to Rick Strassman, Clinical Associate Professor of Psychiatry at the University of New Mexico (UNM) School of Medicine, who is famous for his groundbreaking research on the effects of DMT on human subjects. Between 1990 and 1995, Strassman administered hundreds of doses of DMT by injection in a purified form to some 60 volunteers, carefully documenting the experiences they described. A significant portion of the volunteers reported similar experiences, which included seeing extraordinary geometric patterns and having profound encounters with non-human entities. (The reader will recall that geometry is mentioned in Sting's DMT trip.) In many cases the entities were elf-like or fairy-like in nature.

Strassman came to the conclusion that the powerful visionary experiences induced by DMT are not mere hallucinations. Rather, he believes that DMT affects the brain in such a way as to facilitate access to "other planes of existence"—similar to switching the dial on a TV set from one channel to another. "I claim little understanding of the physics underlying theories of parallel universes and dark matter," Strassman explained. "What I do know, however, causes me to consider them as possible places where DMT might lead us…"[17] Strassman further suggests that the entire gamut of naturally occurring "psychedelic states," from alien abduction experiences to near-death experiences, can be attributed to "excessive DMT production [in the human body], coming from the mysterious pineal gland."[18] His theory of the pineal gland as the body's source of DMT is supported by a 2013 study, published in the journal *Biomedical Chromatography*, in

which DMT was supposedly found in the pineal glands of live rats.

In view of Strassman's research, it's interesting to note that DMT has been found in the body fluids of schizophrenics. Schizophrenia, with its disturbing hallucinations and delusions, is widely considered the most debilitating of all the mental illnesses. Like a "DMT trip," it can cause the individual to undergo a complete loss of contact with consensus reality. The possible role played by DMT in the symptoms of schizophrenia is a matter sorely in need of scientific investigation.

It ought to be clear to the reader by now that the pineal gland is an extremely important organ of the body. Not only does it regulate the sleep-wake cycle by producing melatonin, it could also be the "seat of the soul," playing a role in the way we perceive reality. If, as suggested earlier, the pineal gland is influenced by magnetic fields, either independently or by means of the radical pair mechanism, then clearly this has big implications with respect to our mental, physical—and perhaps even spiritual—health. For the moment, let us return to the topic of circadian rhythms.

The experiments of Rutger Wever

The German scientist Rutger Wever (1923–2010) made some invaluable contributions to the field of chronobiology. At the Max Planck Institute in Erling–Andechs, Germany, Wever and his colleagues constructed an underground bunker consisting of two rooms, to be used as an experimental station in which to study the circadian rhythms of humans kept under prolonged isolation from external time cues. Both rooms were completely cut off from natural variations in light, noise, temperature, and so forth. Each room was furnished with its own kitchen, living room, bedroom, and bathroom. Between 1964 and 1989, Wever used the bunker as the basis of some 420 "time isolation" experiments, studying under countless different conditions the circadian rhythms of around 450 volunteers. He discovered that when allowed to "run freely" (in the absence of time cues) our circadian rhythms tend to follow periods close to 25 hours.

Wever was surprised to find that most of the participants enjoyed their period of isolation in the bunker, often asking, immediately upon resurfacing, when they could do the experiment again. "They feel so well, to be alone and undisturbed," he once commented. "On the average, it is more difficult to take the subject out of the room than put him in."[19]

In perhaps his most important study, Wever looked at whether electromagnetic fields can influence human circadian rhythms. He arranged the rooms identically in every aspect, save for shielding one of the rooms from external electric and magnetic fields, including that of the Earth. The experiment followed the normal procedure in which participants lived in the rooms for periods of between four to six weeks, while Wever kept them under close observation with respect to such factors as body temperature, sleep-wake cycles, and urinary excretion of potassium, sodium, and calcium.

Wever observed only a slight desynchronization in the circadian rhythms of participants living in the "non-shielded" room; either their circadian rhythms remained close to 24 hours, or at the very least in harmony with the normal circadian rate. By comparison, he observed a dramatic desynchronization in the circadian rhythms of participants living in the "shielded" room, to the point where several variables showed no harmonic relationship with the primary rate. This indicated that isolating oneself from the electromagnetic environment of the Earth causes one's circadian rhythms to become almost completely desynchronized.

Wever was curious to see if any changes would occur in the circadian rhythms of the

participants if he introduced various electric and magnetic fields into the shielded room. He experimented with static electric fields of 600 V/m as well as static magnetic fields of 1.5 Oe (oersted), yet neither had any effect. He then introduced into the shielded room a 10 Hz electric field (at 2.5 V/m). The result was remarkable: the participants began to exhibit virtually normal circadian rhythms. Aware that 10 Hz is a "frequency of the Earth" because of its significance in relation to a phenomenon called Schumann resonance, he came to consider it the prime timer of biological cycles. The connection between Weaver's research and Schumann resonance is a fascinating one, and it is this connection we will now turn to.

Schumann resonance

In the 1950s, a German scientist named Winfried Otto Schumann (1888–1974)—after whom Schumann resonance is named—predicted that electromagnetic signals resonate in the cavity between the Earth's surface and the ionosphere. The ionosphere is a region of the atmosphere, extending from a height of about 40 miles to 250 miles above the surface of the Earth, containing atoms that have been ionized by radiation from the sun. The fact that the ionosphere reflects certain frequencies of radio waves is exploited in the case of shortwave radio. In shortwave radio, radio waves, which normally propagate in straight lines, are bounced between the ground and the ionosphere, and hence make their way around the Earth's curved surface. Shortwave makes possible the transmission of radio signals over extremely long distances. Perhaps the most famous shortwave radio broadcast is the BBC World Service, which has been in operation since 1932.

An illustration of lightning activity giving rise to Schumann resonance in the Earth-ionosphere cavity. Image courtesy of NASA.

Schumann calculated mathematically that the fundamental frequency of the Earth-ionosphere cavity is 10.6 Hz, with harmonics at 18.4, 26.0, 33.5, and 41.1 Hz. The resonances he predicted were first measured reliably in the early 1960s. These resonances are confined to the ELF portion of the electromagnetic spectrum, beginning at approximately 5 Hz and extending to 60 Hz, and

occur at peaks of approximately 7.8 (fundamental), 14.2, 19.6, 25.9, and 32 Hz. That these figures are some 40 percent lower than the ones calculated by Schumann can be explained as a result of damping (energy loss).

Schumann resonances are excited by global lightning activity. Basically, each burst of lightning on Earth—globally, there are some 50 lightning incidents every second—creates within the Earth-ionosphere cavity electromagnetic waves that circle around the planet. If the waves are of the right length and also in phase with each other, they can combine in such a way as to give rise to a resonance effect. Resonance occurs when a system is subjected to an oscillating force having a frequency close to its own natural frequency. Pushing a child on a swing involves resonance. As long as each push of the swing is in rhythm with the initial swing, the swing will climb higher and higher. Resonance phenomena can be extremely powerful and destructive; there are incidents where groups of soldiers marching in step have caused bridges beneath them to collapse. To prevent this from happening, soldiers are ordered to break step when crossing bridges.

Schumann resonance is simply the natural frequency of the Earth-ionosphere cavity—the frequency at which it vibrates naturally. Although, as noted earlier, there is a range of Schumann resonances, the frequency of greatest significance is the fundamental frequency. The fundamental frequency, or first harmonic, is the lowest frequency at which a system vibrates naturally. The remaining harmonics are integral multiples of the fundamental frequency. Let me state again that the fundamental frequency of the Earth-ionosphere cavity, as calculated mathematically, is 10.6 Hz.

Because the Schumann resonance frequencies are defined by the dimensions of the Earth, they're probably more or less the same today as when life first arose on the planet. Even so, the frequencies fluctuate slightly, owing to a large extent on the ever-changing condition of the ionosphere. According to NASA, "variations in the resonances correspond to changes in the seasons, solar activity, activity in Earth's magnetic environment, in water aerosols in the atmosphere, and other Earth-bound phenomena."[20]

Wever's discovery that a 10 Hz electric field can restore normal circadian rhythms in people living in isolation from natural sources of electromagnetic radiation takes on immense significance when examined in relation to Schumann's discovery that 10.6 Hz is the "heartbeat" of the Earth. The similarity between the two frequencies cannot be a coincidence. Rather, it suggests that we—and by extension all living things on the planet—are "tuned to" the Earth's 10.6 Hz heartbeat. Constituting additional support for this theory is that the brain waves known as "alpha waves" have a frequency of between 8 to 13 Hz, with 10 Hz being the mean alpha frequency of adulthood.

The alpha wave state involves having the eyes closed and letting the mind drift, such as occurs during daydreaming, hypnosis, and meditation. Normal waking consciousness, the state you'd be in now while reading this book, is characterized by beta waves (13 to 30 Hz). The point worth noting here is the similarity in frequency between the rhythms of the body (brain wave activity and circadian rhythms) and the rhythms of the Earth (Schumann resonances). Both occupy the lower end of the ELF range.

Geomagnetic activity and human health

Schumann resonance is one aspect of the natural electromagnetic environment. Another, equally important aspect is the Earth's magnetic field. The possibility that human health, both mental and

physical, is affected by fluctuations in geomagnetic activity has been the focus of much speculation, yet has also been thoroughly investigated scientifically. Since solar activity and geomagnetic activity go hand in hand, it's worth turning our attention to the Sun for a moment.

Our unstable sun

Although we tend to think of the Sun as stable and unchanging, conditions there vary from instant to instant. As these conditions vary, so too does its energy output. It's a little-known fact that the Sun rotates on its axis. What makes this rotation noticeable is the movement of dark specks, called sunspots, across its surface.

Sunspots, which have a lifetime of several days to several weeks, are areas where the solar magnetic field is so intense as to inhibit the flow of hot gases from the Sun's interior to its surface. Sunspots are therefore cooler than the rest of the Sun's surface and hence appear dark. Serious scientific study of sunspots began in the early 1600s with the invention of the telescope. It was the astronomer Galileo Galilei who, in 1611, discovered the rotation of the Sun by observing through his telescope the movement of sunspots. (Actually, he didn't observe the Sun directly through his telescope, because he knew that doing so would damage his eyes. Rather, he placed a piece of paper behind the eye piece of his telescope, thus projecting onto the paper an image of the Sun.)

In 1843, after having observed the Sun on an almost daily basis over a 17-year period, a German pharmacist and amateur astronomer named Samuel Heinrich Schwabe (1789–1875) came forward with a fascinating discovery: sunspots vary in number in a cycle of about 10 years. Today we refer to this as the sunspot cycle and we know it's an average of 11.1 years, not 10. In any given sunspot cycle, the number of sunspots visible on the Sun increases from practically naught to around 100 or more. "Solar minimum" is the point in this cycle when the Sun is at its quietest and sunspots are lowest in number; "solar maximum" is the point in this cycle when the Sun is at its most active and sunspots are highest in number.

Sunspots are the cause of both solar flares and coronal mass ejections (CMEs). Despite being closely related and often occurring together, solar flares and CMEs are not the same thing. A solar flare is a brief, powerful flash of electromagnetic radiation (including radio waves and X-rays) from the Sun's surface. Because they travel at the speed of light (300,000,000 m/s), they reach Earth almost instantaneously. A CME, on the other hand, is a huge, bubble-shaped ejection of plasma that expands outward from the Sun's corona. It is essentially a powerful gust of solar wind. CMEs take two to three days to reach Earth.

The solar wind, as opposed to blowing in a consistent fashion, undergoes variations in speed and density. Strong gusts of solar wind—a CME, of course, being a *powerful* gust of solar wind—impact the magnetosphere and cause it to distort. We call these disturbances in the magnetosphere geomagnetic disturbances. Geomagnetic storms are simply geomagnetic disturbances of high magnitude. CMEs are more likely to cause geomagnetic storms than are solar flares; CMEs are first and foremost solar wind events, whereas solar flares are first and foremost electromagnetic events.

The Carrington Event

The largest geomagnetic storm ever recorded, known as the Carrington Event, occurred on September 2, 1859, during a period of solar maximum. Just prior to noon on September 1, the English astronomer Richard Christopher Carrington (1826–1875)—after whom the incident is

named—saw in an image of the Sun projected by his telescope "two patches of intensely bright and white light" appear over a group of sunspots he'd been sketching.[21] Carrington says he was "somewhat flurried by the surprise" and "hastily ran to call someone to witness the exhibition with me…[yet]…on returning within 60 seconds… [I] was mortified to find that it was already much changed and enfeebled."[22] Before long the white spots had vanished altogether.

It turns out that what Carrington saw was a white-light solar flare. The solar flare was accompanied by an intense CME, which reached Earth within 17.5 hours, triggering a huge geomagnetic storm. (Why did the CME reach Earth so quickly when they normally take days to do so? Because it was actually the second of two closely spaced CMEs. The first of the two CMEs reached Earth on August 28. This cleared the way for the second CME.)

So powerful in magnitude was the Carrington Event that it brought the northern lights as far south as Cuba and Venezuela and the southern lights as far north as Queensland, Australia. In fact, according to Daniel Baker of the University of Colorado's Laboratory for Atmospheric and Space Physics, "people in the northeastern U.S. could read newspaper print just from the light of the aurora."[23] Yet the Carrington Event did more than produce beautiful auroral displays in parts of the world where they are not normally seen. It also caused telegraph systems worldwide to go haywire, as a result of inducing currents in telegraph lines. Sparks leapt from telegraph machines, shocking telegraph operators and even setting fire to telegraph paper.

In today's age, in which just about everything runs on electricity, a geomagnetic storm of the same magnitude as the Carrington Event would be extremely devastating, causing global chaos. Science journalist Michael Hanlon paints a grim picture of what would transpire if "a rerun of the Carrington Event were to happen tomorrow":

> "[P]ower lines would melt, electrical sub-stations would catch fire, half the world's telephone grid would be knocked out, telecoms satellites would go down and the internet would be crippled, perhaps for a year. There would be massive disruptions to food and water supplies, water treatment and distribution, as well as the global banking system. All the finely tuned technological threads upon which our civilisation depends would be strained to breaking point."[24]

Alexander Chizhevsky

That geomagnetic disturbances of high intensity have the potential to play havoc with electrical systems is well-documented. But what about the possibility of biological effects resulting from geomagnetic disturbances? This question comes under the domain of heliobiology, "a branch of biophysics that studies the influence of changes in solar activity on terrestrial organisms."[25] (Helios is the Sun god in Greek religion.)

The father of heliobiology was the Soviet biophysicist Alexander Chizhevsky (1897–1964). He developed the theory that periods of "mass movement"—periods when there are wars, revolutions, uprisings, large migrations, and so on—follow a regular cycle corresponding to that of the Sun. In short, he found that when solar activity peaks so too does mass unrest. He also looked at the link between solar activity and epidemics of cholera, influenza, and so on, throughout history, and discovered that peaks in the incidence of epidemics coincide with peaks in solar activity. Sadly, Chizhevsky was a victim of Stalin's ruthless dictatorial regime; his career as a scientist ended around 1939, when he was sent off to a slave labor camp. On a more positive note, heliobiology, for a long time eschewed by scientists outside the Soviet Union, has gained

acceptance as a legitimate branch of science.

"Does the Earth's magnetic field cause suicides?"

This is the title of a 2008 article that appeared in *New Scientist*. Mentioned in the article is a study conducted by Oleg Shumilov of the Institute of North Industrial Ecology Problems (INEP) in Russia regarding whether there is a link between geomagnetic activity and suicide. By looking at geomagnetic data for the period 1948 to 1997, Shumilov identified three seasonal peaks in geomagnetic activity every year: the first from March to May, the second in July, and the third in October. He then looked at suicide statistics pertaining to the same period for the northwestern Russian city of Kirovsk. He found that the peaks in geomagnetic activity corresponded to peaks in the incidence of suicide.

A 2006 Australian study led by Michael Berk of Deakin University compared geomagnetic data and national suicide statistics for Australia for the period 1968 to 2002. The study, which included a total of 51,845 cases of male suicide and 16,327 cases of female suicide, found that "suicide amongst females increased significantly in autumn during concurrent periods of geomagnetic storm activity."[26] No such pattern was detected in the case of males. "This suggests that perturbations in ambient electromagnetic field activity impact behavior in a clinically meaningful manner."[27] In Australia, as with most other countries, suicide is far more common among males than females—hence the higher percentage of males in the study. I should add that autumn in Australia is from March to May—this being one of the peaks in geomagnetic activity identified by Shumilov.

Numerous other studies indicate a link between geomagnetic activity and suicide. Taken as a whole, these studies point to the conclusion that large geomagnetic disturbances contribute to suicide by pushing over the edge those who already suffer from depression and other mental health problems, in the same way a marble resting on the edge of a table will drop to the floor if disturbed by a minor vibration.

According to Kelly Posner, a psychiatrist at Columbia University, "The most plausible explanation for the association between geomagnetic activity and depression and suicide is that geomagnetic storms can desynchronize circadian rhythms and melatonin production. The circadian regulatory system depends upon repeated environmental cues to [synchronize] internal clocks. Magnetic fields may be one of these environmental cues."[28]

Posner's explanation leads us back to the mysterious pineal gland. Again we're forced to consider the possibility that the pineal gland is sensitive to magnetic fields. We already know the pineal gland is (indirectly) sensitive to light. Can exposure to magnetic fields, as with exposure to light, alter the production of melatonin by the pineal gland and in so doing affect the sleep-wake cycle?

Before we look into this question, I wish to emphasize the fact that having a disrupted sleep-wake cycle (more broadly, disrupted circadian rhythms) and abnormal melatonin levels impacts not only our mental health, as in promoting depression, but our physical health as well. Indeed, the connection between geomagnetic activity and human health encompasses more than depression. In particular, there is strong evidence that unusually high levels of geomagnetic activity can affect the health of the cardiovascular system (the heart and blood vessels).

The melatonin connection

A number of studies support the notion that geomagnetic disturbances alter—specifically, reduce—melatonin levels in the body. One such study, led by Andi Weydahl of Finmark University College, was conducted in the town of Alta, Norway. Located at latitude 70° North, Alta is one of the northernmost towns in the world and is famous for its stunning auroral displays. There are only two seasons in Alta: winter and summer. Winter lasts from November to January, throughout which there is barely any sunlight, including several weeks of total darkness. Geomagnetic disturbances are more intense near the poles than at lower latitudes, making Alta an ideal location in which to carry out the study.

By monitoring melatonin concentration in samples of saliva collected from 25 subjects during the day and night and at different times of the year, while simultaneously keeping track of variations in local geomagnetic activity, Weydahl and his team discovered a correlation between geomagnetic activity and the circadian amplitude of melatonin. This correlation was apparent in the case of geomagnetic activity above a certain magnitude only. They found that when changes in geomagnetic activity were greater than 80 nT (nanotesla) in a three-hour period, concentrations of salivary melatonin significantly decreased. (The results of the study appear in a 2001 issue of the journal *Biomedicine & Pharmacotherapy*.)

A 1999 study led by James B. Burch of the University of Colorado looked at geomagnetic disturbances—both alone and in combination with 60 Hz magnetic field and ambient light exposures—on urinary excretion of the major melatonin metabolite 6-hydroxy melatonin sulfate (6-OHMS) in 132 male electric utility workers. The quantity of 6-OHMS in the urine is greater at night than during the day, reflecting pineal melatonin secretion. It is the substance formed when melatonin is metabolized (broken down) in the liver. Electric utility workers were chosen for the study because of their abnormally high exposure to 60 Hz magnetic fields. Each participant was required to wear at the waist a data-logging meter that monitored their 60 Hz magnetic field and ambient light exposure.

Let me preface here that if you live in the United States the electricity supplied to your home —known as mains electricity—is at 120 volts and 60 Hz. (In the United Kingdom, mains electricity is supplied at 230 volts and 50 Hz.) Any wire carrying a 60 Hz electric current will produce a 60 Hz magnetic field. This means that every person in the United States receives some degree of exposure to 60 Hz magnetic fields, such as from power lines. It figures that exposure to magnetic fields is greater for people employed in the electric utility industry than it is for people employed in most other industries.

According to Burch and his team, the participants displayed reduced overnight urinary excretion of 6-OHMS on days with higher levels of geomagnetic activity, indicating that geomagnetic disturbances decrease melatonin production in the body. The scientists also observed that mean overnight 6-OHMS excretion was 20 percent lower on days when the level of geomagnetic activity exceeded 30 nT, with the effect increasing to 28 percent for geomagnetic activity of 40 nT and 38 percent for 45 nT. The artificial magnetic field aspect of the study was just as astonishing, revealing an association between increased 60 Hz magnetic field exposure and decreased melatonin production. “Reductions in nocturnal 6-OHMS excretion…were greater on days when geomagnetic activity and 60 Hz [magnetic field] exposures were both elevated, suggesting a common biological mechanism.”[29]

That both geomagnetic disturbances and 60 Hz magnetic fields have been shown to lower melatonin production is extremely significant. Constituting further evidence that artificial ELF EM fields can lower melatonin production in humans is a 1990 study led by Bary Wilson of Pacific Northwest Laboratories. Wilson and his colleagues looked at overnight excretion of 6-

OHMS in 42 volunteers who used either conventional or modified continuous polymer wire (CPW) electric blankets for approximately eight weeks. The difference between the conventional electric blankets and the CPW electric blankets is that the latter switched on and off twice as often and produced 50 percent stronger magnetic fields. (Electric blankets emit relatively strong magnetic fields and the fact that people tend to use them for many hours at a time makes them high risk devices from an EM exposure perspective.)

Wilson and his colleagues discovered that whereas the participants who used conventional electric blankets showed no variation in 6-OHMS excretion, seven of the 28 participants who used CPW electric blankets "showed statistically significant changes in their mean nighttime 6-OHMS excretion."[30] These findings suggest that "exposure to pulsed DC or extremely low frequency electric or magnetic fields of sufficient intensity and duration can affect pineal gland function in certain individuals."[31]

Conclusions

In this chapter we've covered a vast amount of scientific terrain, discussing the radical pair mechanism, cryptochrome, circadian rhythms, Schumann resonance, geomagnetic disturbances, melatonin, the pineal gland, DMT, and much else. By standing back for a moment and seeing how these various topics fit together, a number of important conclusions emerge. I base these conclusions on nothing more than the available scientific evidence.

- To say there is no plausible biological mechanism by which electromagnetic fields can interact with the human body is completely erroneous. We are sensitive to electromagnetic fields via the cryptochrome in the retinas of our eyes as well as via the magnetite crystals in our brain and sphenoid/ ethmoid sinus complex. This subconscious form of magnetoception—or "sixth sense"—keeps us linked to the electromagnetic environment of the Earth.

- The electromagnetic environment of the Earth, which comprises the Schumann resonance frequencies and the geomagnetic field, is confined to the ELF portion of the electromagnetic spectrum (3–300 Hz). The human body, being "tuned to" the electromagnetic environment of the Earth, is affected by changes in the geomagnetic field as well as by Schumann resonance fluctuations. Geomagnetic disturbances, by reducing pineal melatonin production and thereby altering the sleep-wake cycle, can have a negative impact on our mental and physical health. Artificial EM fields that exist within the same frequency range as that of the Earth can likewise impact our health by reducing pineal melatonin production.

- The geomagnetic field, in conjunction with the Schumann resonance frequencies, acts in addition to light as a zeitgeber of the body's circadian rhythms, regulating pineal melatonin production. Furthermore, the sensitivity of the pineal gland to both natural and artificial EM fields involves a similar mechanism to that by which light functions as a zeitgeber of the sleep-wake cycle. In the latter case, the SCN is aware of how much light is present in the environment thanks to intrinsically photosensitive retinal ganglion cells (ipRGCs). The SCN passes this information on to the pineal gland, telling it to produce melatonin when it's dark (night time) and to cease producing melatonin when it's light (daytime). If we suppose that the cryptochrome in the human retina is involved in

circadian photoreception (such that ipRGCs owe their photosensitivity to cryptochrome), then it is via cryptochrome and the radical pair mechanism that the pineal gland is sensitive to EM fields.

3 Allergic to Electricity

In the previous chapter we established that the human body is tuned to, and responds to changes within, the electromagnetic environment of the Earth, such that geomagnetic disturbances can reduce melatonin production and thereby disrupt the sleep-wake cycle. We also looked at evidence showing that exposure to artificial EM fields can likewise reduce melatonin production. In this chapter we'll examine a number of other biological effects associated with exposure to artificial EM fields, some of which come under the domain of "mind control."

If, like me, you live in an urban environment, you're bound to receive a high amount of exposure to EM radiation from sources too numerous to mention. Cities are grossly polluted with EM radiation, or "electrosmog," and are becoming more polluted every year as our use of technology expands and technology itself becomes ever more sophisticated. If, on the other hand, you live in the country, it's probable you receive a low to moderate amount of EM exposure. Some people choose to live in the country solely because they're convinced that artificial EM fields make them acutely ill—a condition known as EM hypersensitivity (EHS). EHS is commonly assumed to be psychosomatic in origin; though, as we'll see in the latter-half of the chapter, much compelling evidence suggests otherwise.

Smart meter health problems

Although I wouldn't go so far as to call myself "hypersensitive" to EM fields, I have reason to believe that during one period in my life I suffered ill effects from long-term exposure to radio frequency (RF) radiation. As with any story, it's necessary to begin at the beginning. In early 2010, my wife (then girlfriend) and I moved into a small brick dwelling located in the northern suburbs of Melbourne. We found our new home reasonably pleasant and settled in quickly. Most of all, we were grateful to have a place of our own and to be paying such affordable rent.

One day in mid-2012, a technician paid a visit to our home to replace our analogue electricity meter with a "smart meter" as part of a Victorian Government plan to upgrade the electricity network—a plan that's currently being implemented in other states of Australia. Smart meters are at present being installed in homes and businesses across the United States, and the same is happening in numerous other countries, including Canada, Italy, the United Kingdom, and New Zealand.

Smart meters and analogue meters are similar to the extent that both devices record your electricity usage for billing purposes. But whereas analogue meters are connected to the grid by means of wires, smart meters are digital, wireless, two-way communication devices that operate in the RF range. They record your electricity usage at frequent intervals and send that data directly to your electricity supplier. They enable your electricity supplier to monitor your power usage closely without having to send a technician to your home to do so manually. Not unreasonably, the surveillance capabilities of smart meter technology have sparked concerns among citizens who value their privacy and don't appreciate being "spied on" by the powers that

be.

Although at first I was annoyed that a smart meter had been installed in our home without our consent, I soon forgot the device was there and became absorbed in more pressing concerns. At the time I was busy working on a major writing project, which involved spending much time at home in front of the computer. (I'm aware computers emit various forms of EM radiation. To minimize my EM exposure while working in front of a computer, I always make sure the screen is positioned a good distance away from my body.) The project was coming along smoothly and I was confident I'd make the deadline on time.

As the weeks progressed, however, I noticed a gradual decline in my ability to concentrate on the project. I soon found *any* activity that required sustained concentration challenging. The problem appeared to stem from an intense feeling of agitation in the very core of my being. There were times when the feeling became so intense that I'd suddenly leap from my chair and dash from my office without completing the sentence I'd been writing. It's as if my body was constantly on "alert mode."

Thinking that perhaps my health had suffered from an overly homebound lifestyle, I began to make more trips outdoors, either going for walks around the block or visiting the park down the road. I felt much better when out of the house; the feeling of agitation lifted to some extent, only to come back as soon as I returned home. My wife revealed to me that she, too, was plagued by a feeling of deep-seated agitation and was experiencing concentration issues. It didn't take us long to recognize that the problem coincided with the installation of the smart meter in our home.

The penny dropped when, throughout the ensuing months, I came across a series of online articles concerning cases in the United States and Australia of people claiming to have suffered health problems as a consequence of living with a smart meter in their home. Among the health problems frequently cited were "agitation" and "inability to concentrate"—the same problems my wife and I were experiencing.

One article that came to my attention concerned a family of six in the Melbourne suburb of Keilor East. After a smart meter was installed in their neighbor's home, the Florios began to experience "constant headaches and sleep deprivation."[1] The family became what Ms. Florio described as "smart meter refugees," opting to abandon their home because their suffering had reached an unbearable level.[2]

A similar article concerned a couple from Mt. Eliza, Melbourne, named Vic and Rosemary Trudeau. Just days after a smart meter was installed in their home, Rosemary began feeling extremely "irritable" and both she and Vic experienced a "high pitched ringing" in their heads. Other shared symptoms included nausea, headaches, difficulties concentrating, heart palpitations, and insomnia. The symptoms would disappear when they left home and reappear as soon as they returned home. Since their power company refused to remove the device, the Trudeaus were left with no other option but to abandon their home and take up residence in their camper van. "I'd never had any [health] problems [like these] before, and I'd lived in the house 22 years," Rosemary insisted.[3]

Unlike the Florios and the Trudeaus, my wife and I didn't abandon our home, though we did consider the possibility of moving. The opportunity to move arose when, in early 2013, my wife secured a job in Darwin, Northern Territory (where, fortunately, smart meters haven't yet been introduced). Our health problems vanished for good soon after we relocated to Darwin.

A brief Internet search will reveal that many people all over the world are experiencing health problems related to smart meters. These include stress, agitation, anxiety, irritability,

insomnia, persistent headaches, ringing in the ears, eye problems, severe memory loss, mental confusion, inability to concentrate, heart palpitations, nausea, urinary problems, hyperactivity, fatigue, dizziness, and nose bleeds.

Isn't this all a bit over the top? Surely those reporting such problems are either deluded or mentally ill. To be honest, had I not experienced some of these problems myself—and my wife also—it's likely I would have adopted the "deluded or mentally ill" explanation and looked no further into the matter. One person I talked to about my smart meter health concerns suggested, as a joke, I wear a tinfoil hat. The term "tinfoil hat" is used in a derogatory fashion to refer to people inclined toward paranoid or conspiratorial beliefs. The term makes those who think cellphones, Wi-Fi—or indeed smart meters—pose a danger to human health look silly or crazy.

Another health problem I experienced during my period of exposure to smart meter radiation was lowered immune function. It's a well-known fact that when the immune system is weak it has difficulty doing its job, which is to defend the body against pathogens (disease-causing microbes). If you find yourself getting infections frequently and if these infections are difficult to eliminate, it's a good indication your immune system is weak. Immediately after the smart meter was installed, my immune system suffered a devastating blow. First, a hair on my leg became ingrown and highly infected, necessitating a strong dose of antibiotics. This was followed by a persistent fungal infection in a certain part of my body. My immune system regained its strength as soon as my wife and I moved. Later we'll look at evidence showing that exposure to artificial EM radiation can compromise immune function in animals and humans.

The WHO report

Are smart meters really as harmful as many believe? Before we focus specifically on smart meters, it would be valuable to take a look at the World Health Organization's stance on non-ionizing (or low level) EM fields and human health. The World Health Organization (WHO), a specialized agency of the United Nations (UN), is an authority on matters of international public health. Established in 1948, the WHO is involved in coordinating international health activities and in aiding governments to improve health services. It goes without saying that their opinions are widely respected and taken seriously.

Featured on the WHO website is a several page report on EM fields and human health, simply titled *Electromagnetic Fields (EMF*), of which I will now give a brief summary. The WHO Report explains something we know already: ionizing forms of EM radiation—x-rays, gamma rays, and so forth—carry sufficient energy to break molecular bonds and hence damage living tissue, whereas non-ionizing forms of EM radiation—radio waves, ELF electric and magnetic fields, and so on—lack sufficient energy to break molecular bonds. Nobody disputes the fact that ionizing EM radiation is harmful to the body; the debate is focused on whether non-ionizing radiation is harmful to the body.

The Report gives particular emphasis to radio frequency (RF) radiation, which lies in the frequency range between 3 kilohertz (kHz) and 300 gigahertz (GHz) and is non-ionizing. Microwaves are one form of RF radiation. The Report acknowledges that RF radiation of high intensity can heat tissue and is therefore harmful to the body. (Earlier I explained that a microwave oven uses high intensity RF radiation to cook food.) The Report goes on to state that because RF radiation of low-intensity—such as that emitted by cellphone handsets and base stations, radio and television transmitters, and radar antennas—causes negligible to zero heating of body tissue, it is extremely unlikely to harm the body.

The Report also addresses the topic of extremely low frequency (ELF) electric and magnetic fields and human health. Whereas RF fields are generally associated with telecommunications (radio, television, radar, cellphones, and so forth), ELF electric and magnetic fields are generally associated with electric power distribution and appliances that use mains electricity. The power lines that run past your home, the electric kettle in your kitchen, the clock radio situated on your bedside table—all are sources of ELF electric and magnetic fields. The Report explains that exposure to both induces currents in the body.

For example, if you were to stand under a 60 Hz power line, the electric field produced by the power line would induce an electric current that flows from your head to your feet, while the magnetic field produced by the power line would induce circulating electric currents within your body. "In virtually all ordinary environments, the levels of induced currents inside the body are too small to produce obvious effects," the Report states.[4] Listed under "obvious effects" are "nerve and muscle stimulation and changes in nerve cell excitability in the central nervous system."[5] The suggestion is that because these "obvious effects" are absent with respect to exposure to common, everyday, low-strength ELF electric and magnetic fields, such fields pose no harm to our health.

The following two statements from the Report give a clear indication of where the WHO stands on the issue of non-ionizing EM fields and human health:

"Despite extensive research, to date there is no evidence to conclude that exposure to low level [non-ionizing] electromagnetic fields is harmful to human health."[6]

"With more and more research data available, it has become increasingly unlikely that exposure to electromagnetic fields constitutes a serious health hazard, nevertheless, some uncertainty remains."[7]

To state there is "no evidence to conclude that exposure to low level [non-ionizing] electromagnetic fields is harmful to human health" but that "some uncertainty remains" is somewhat wishy-washy. After reading the Report in its entirety, one gets the impression the WHO is secretly thinking: We'd like to tell the public that exposure to nonionizing EM fields is completely safe, but since doing so would make us look negligent or biased, instead we'll tell them we're 99 percent sure EM fields are safe. That way they'll stop worrying about the matter.

Common sense tells us it would be extremely bad news for the military and the telecommunications and electric utility industries if the WHO came forward and admitted that exposure to non-ionizing EM radiation is linked to cancer and other serious health problems, never mind the impact this would have on each and every one of us, given that electricity is the lifeblood of modern society. Clearly the best approach on the part of the authorities would be to play down the issue as much as possible, without entirely dismissing it.

It's worth noting that in 2002 the International Agency for Research on Cancer (IARC), which is part of the WHO, classified ELF magnetic fields as a possible human carcinogen ("Class 2B"), due to there being a statistical association between "higher level residential ELF magnetic fields and [an] increased risk for childhood leukaemia."[8] In 2013, IARC classified RF radiation as another Class 2B carcinogen, stating "Positive associations have been observed between exposure to radiofrequency radiation from wireless phones and glioma and acoustic neuroma."[9] Given that IARC's list of Class 2B carcinogens includes such substances as coffee, gasoline, bracken fern, and welding fumes, one is led to believe that one is no more likely to develop cancer from excessive cellphone use as one is from feasting daily on bracken fern fiddleheads and gulping large quantities of coffee.

Public exposure limits

Just about every country has public exposure limits in place for both ELF (50/60 Hz) magnetic and electric fields and RF radiation. In Australia, the exposure limits for ELF electric and magnetic fields were set by the National Health and Medical Research Council (NHMRC) in 1989 and are similar to limits present in many other countries. (These limits are currently in the process of being updated.) NHMRC states that in areas where members of the general public experience continuous exposure, the electric field strength should not exceed 5 KV/m while the magnetic flux density should not exceed 0.1 mT. To the best of my knowledge, the United States has no federal exposure limits in place for ELF electric and magnetic fields.

A worker stands amongst electrical equipment. Image courtesy of U.S. Agency for International Development.

We now come to RF radiation. In 2002, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) released a document titled the *Radiation Protection Standard—Maximum Exposure Levels to Radiofrequency Fields—3 kHz to 300 GHz*. The exposure limits set out in the Standard are based on guidelines established in 1998 by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The limits take into consideration such adverse biological effects as electrical stimulation, heating of tissues, and nuisance auditory effects. Again, the heating aspect is strongly emphasized, with the assumption being that RF fields pose no threat to one's health if they are not of high enough intensity to heat bodily tissue and cause tissue damage.

The RF radiation exposure limits listed in the Standard for the general population and with respect to long-term exposure are expressed in power flux density (power per unit area) and range from 0.2 mW/ cm^2 at 10 MHz to 400 MHz to 1 mW/cm^2 at 2 GHz to 300 GHz. The latter limit of 1 mW/cm^2 at 2 GHz to 300 GHz applies to cellphones, as 2 GHz is close to the frequency at which most cellphones operate. We find roughly the same limits in place in the United States and numerous other Western countries. For the sake of simplicity, we will say that 1 mW/cm^2 is the RF radiation exposure limit for the general population.

When you expose yourself to common sources of RF radiation, the molecules of your body vibrate, which in turn causes heating. As I said, the same principle is at work when food is

heated inside a microwave oven. In the case of talking on a cellphone, the specific area of your head to which the phone is in contact will absorb the greatest amount of RF radiation, becoming ever so slightly warm. Yet your overall body temperature will not be affected. RF safety standards ensure that the energy emitted by RF sources such as cellphones is low enough not to measurably increase body temperature.

The unit of measurement for the amount of RF radiation absorbed by the body is called the specific absorption rate (SAR) and is expressed in watts per kilogram (W/kg) or milliwatts per gram (mW/g). The ARPANSA SAR limit for cellphone handsets is 2 W/kg (using 10 gram averaging mass). This limit is such that talking on a cellphone will produce a maximum rise in temperature in the side of the head no greater than 0.1°C—far less than the increase in temperature required to destroy bodily tissue.

Although it's reassuring to know that cellphones and other devices don't emit enough RF radiation to "cook" our bodies the same way a microwave oven does, much convincing evidence shows that exposure to low-level RF radiation can produce biological effects that have nothing to do with the heating of tissue. It is these non-thermal or athermal effects, rather than the thermal effects, that are of relevance to our present discussion. There seem to be at least two attitudes within the mainstream scientific community toward non-thermal biological effects related to low-level RF radiation exposure: either we are told there is no evidence for such effects, or we are told there is evidence for such effects but that the evidence is controversial and unproven.

My research in this area has taught me that it's futile to expect to receive from the authorities a truthful, straightforward answer as to whether low level RF radiation (indeed, non-ionizing EM radiation in general) can cause harm to our bodies. To get to the truth of the matter, we are left with no other choice but to bypass official sources of information, including ARPANSA and the WHO, and seek out genuine sources of information. Since one of our objectives in this chapter is to find out why smart meters have sparked a flurry of health complaints all over the world, for the time being we will limit our discussion to RF radiation.

Radio–wave sickness

Indications that RF radiation can produce a range of adverse health effects unrelated to heating of the body first began to emerge in the years following World War II, when it was found that radar operators have a tendency to suffer from internal bleeding, jaundice, leukemia, cataracts, headaches, brain tumors, and heart conditions. Later, in the 1970s, Eastern European and Soviet researchers—who had been at the forefront of research on bioelectromagnetics since before the 1950s—began to use the term "radio-wave sickness" to refer to a clinical syndrome in those occupationally exposed to EM fields, particularly RF fields. (Bioelectromagnetics is the study of the interaction between EM fields and biological entities.)

It was accepted as a fact by the researchers that low-intensity EM fields adversely affect the autonomic and central nervous systems of humans and animals. The symptoms they listed for radio-wave sickness include headache, increased fatigue, increased irritability, dizziness, loss of appetite, sleepiness, sweating, difficulties in concentration or memory, depression, emotional instability, rashes, thyroid gland enlargement, and tremor of extended fingers. Also listed, though found to be less common, were hallucinations, insomnia, fainting, and internal organ or intestinal difficulties. As the reader has no doubt recognized already, many of these symptoms are common among "smart meter victims."

The Moscow signal

Of relevance to the topic of early research on the harmful effects of RF radiation on humans is an experiment carried out by the Soviets during the Cold War, in which, beginning in 1953 and continuing over a period of many decades, they beamed low-intensity microwave radiation at the U.S. Embassy in Moscow. The U.S State Department first detected the "Moscow signal," as it came to be called, in 1962, prompting an investigation into the matter by various U.S intelligence agencies, including the Central Intelligence Agency (CIA).

The initial theory put forward to explain the purpose of the signal, whose average intensity varied between 0.002 and 0.018 mW/cm^2, is that the Soviets were using it to activate electronic listening devices hidden in the walls of the Embassy. Yet because the signal was found to be a composite of several frequencies and hence unsuitable for electronic eavesdropping purposes, a second theory was advanced as to its purpose: to induce physiological and behavioral effects among Embassy staff. A Scarsdale, New York, ophthalmologist named Milton Zaret, who was employed by the CIA in 1965 to help ascertain the purpose of the signal, concluded: "Whatever other reasons the Russians may have had, they believed the beam would modify the behavior of personnel."[10]

The building in Moscow, Russia, that functioned as the United States Embassy throughout the time of the Moscow signal incident. Image courtesy of Wikimedia Commons.

The Moscow signal became the focus of a classified research project, called Project Pandora, which was placed under the direction of the Advanced Research Projects Agency (ARPA), a secret organization within the Department of Defense. One of the objectives of Project Pandora was to "investigate possible behavioural and bioeffects (primarily the former) on primates [monkeys] when the latter were irradiated with microwave signals simulating the exposure of Embassy employees in Moscow."[11] According to Robert Becker, a United States orthopedic surgeon and expert in bioelectromagnetics, the monkeys "showed multiple abnormalities of blood composition and chromosomal counts."[12] It's also been alleged that the monkeys exhibited a deterioration in their ability to perform certain tasks.

Yet, disturbingly, Project Pandora also involved human experimentation: The decision was made not to inform Embassy staff about the signal or to attempt to block the signal, but rather to treat the staff as guinea pigs by observing what effects they might suffer as a result of the prolonged irradiation. It wasn't until 1976, when the U.S finally decided to install microwave screening in the Embassy building, that embassy staff—and the rest of the world—became aware

of the situation. The Soviets denied beaming the building with microwave radiation, and in January of 1979 it was discovered the radiation had ceased. (The Moscow signal made a brief reappearance in 1983 and was again reported in 1988.)

Aftermath

After the Moscow signal became public knowledge, a number of epidemiological studies were undertaken to determine in what ways, if at all, Embassy staff had been affected by the radiation. However, the results of these studies are rather sketchy, indicating a desire on the part of the authorities to keep the truth hidden from the public. One such study, undertaken in 1976 by Dr. Abraham Lilienfeld and colleagues at the Department of Epidemiology at Johns Hopkins University, examined the mortality and morbidity of all Moscow staff and dependents from 1953 to 1976. Staff who had served at other Eastern European embassies during the same period of time, as well as their dependents, acted as the control group.

Although the study supposedly found "No convincing evidence… that would directly implicate the exposure to microwave radiation experienced by the employees at the Moscow embassy in the causation of any adverse health effects," this view is not shared by all.[13] In the opinion of Simon Best and Cyril Smith, the study "yielded some provocative findings."[14] These include "a definite significantly raised rate of protozoal intestinal diseases, benign neoplasms, and diseases of the nerves and peripheral ganglia" among Moscow males.[15] They add: "As a group, Moscow personnel suffered significantly more eye problems, psoriasis and other assorted skin conditions (mostly cysts, dermatitis and eczema), as well as depression, irritability, loss of appetite, and difficulty in concentrating."[16]

The latter group of symptoms are all consistent with radio-wave sickness and very much support the theory that the purpose of the Moscow signal was to "modify the behavior of [embassy] personnel." As an interesting addendum, three of those who served as U.S. ambassador to the Soviet Union in the period 1953 to 1976, when the Moscow signal was active, died of cancer. In order of service: Charles Bohlen (1953–1957) died of pancreatic cancer in 1974 at the age of 69; Llewellyn Thompson (1957–1962 and 1966–1969) died of cancer in 1972 at the age of 67; Walter Stoessel (1973–1976) died of leukemia in 1986 at the age of 66, having first developed signs of leukemia in 1976. What makes the three deaths especially noteworthy is that the Moscow signal was beamed directly at the ambassador's office.

Interestingly, the Moscow signal was between 500 and 55 times weaker than the 1 mW/cm^2 exposure limit for the general population. In fact, since the 1950s and at the time of the Moscow signal incident, there existed in the Soviet Union a tremendously stringent RF radiation exposure limit of just 0.001 mW/cm^2 for the general population. Today the limit is higher, at 0.1 mW/cm^2. Of course, the Russians have long acknowledged that there are non-thermal biological effects associated with exposure to low level RF radiation. These effects are also recognized in China, where the limit is also set at 0.1 mW/cm^2.

The Bise study

At the same time the Russians were busy bombarding the Unites States Embassy with microwaves, an important study on the "effects on the human nervous system of low power [RF] energy" was taking place in Beaverton, Oregon.[17] The study, conducted by William Bise of Pacific Northwest Center for the Study of Non-Ionizing Radiation, consisted of eight

experiments completed between July 1975 and June 1976. Five men and five women, ranging in age from 18 to 48 years, were chosen for the study. All 10 subjects were in good health. They included one high school graduate, two secretaries, a housewife, two professional health physicists, an electronics engineer, a hospital intensive care equipment expert, and two secretaries.

In the study, participants were exposed to both continuous wave and pulse-modulated wave RF radiation over a wide range of frequencies while their brain wave activity was monitored by means of an EEG. The tests took place at various times of the day, including at midnight, and some of the tests were conducted inside a Faraday cage (EM shielded room). The continuous wave RF radiation ranged in frequency from 0.1 to 960 MHz and the pulsed modulated wave RF radiation from 8.5 to 9.6 GHz. Power intensity varied from 10^{-16} to 10^{-13} W/cm^2 (which is substantially below typical urban levels).

In the majority of tests, the subject sat on a chair about one meter away from the signal source, while an operator tuned the signal source through its entire range. Because the subject was unable to see the equipment or operator, they had no idea whether the signal source was switched on or off or at what frequency it was set. Each test took approximately 50 minutes. If during that period the subject's brain wave activity altered at a particular signal source dial setting, Bise and his assistants photographed from the cathode ray tube the relevant section of EEG trace and/or recorded the frequency at which the change had occurred.

It was found that both the continuous and pulse-modulated wave RF radiation induced changes in brain wave activity in the male and female subjects. At certain frequencies, the EEG traces of some of the subjects displayed desynchronized alpha waves of 15 to 25 percent higher than normal amplitude, accompanied by slow waves of increased amplitude. At certain other frequencies, the opposite effect was observed—desynchronized alpha waves of 20 to 50 percent lower than normal amplitude (also accompanied by slow waves of increased amplitude). The majority of EEG changes occurred with continuous wave RF radiation between 100 and 960 MHz.

Featured in Bise's 1978 paper is a table showing radio frequencies and correlative EEG changes. This lists all the frequencies that induced changes in brain wave activity, as well as such details as the number of subjects who responded to that frequency and the magnitude of the effect. Bise found that when a subject exhibited alter brain-waves from being exposed to a certain frequency—say, 200 MHz—all he had to do to make their brain wave state revert to normal was either switch off the signal or alter the frequency of the signal. Conversely, if he then changed the signal back to 200 MHz, the subject would again exhibit alter brain-waves. Bise gives plenty of examples of this phenomenon, in the form of EEG traces from various subjects, in his 1978 paper.

In addition to monitoring his subjects by encephalographic means, Bise paid close attention to their behavior and mental condition. He noticed that during the tests the mood and behavior of the subjects, observers, test engineer, and experimenters "appeared to change," with some of them experiencing apprehension, mild irritation, irritability, concentration difficulties, and short-term memory impairment (all of which are symptoms of radio wave sickness). Bise mentions that during one of the pulse-modulated tests performed in the X-band (microwave region) with a power level of only 10^{-12} w/cm^2, he, the subject, and the technician experienced severe headaches. The following day all three "felt mentally and physically sluggish…to the extent that they could do no work."[18] In conclusion, the results of Bise's study strongly suggest that low

level RF radiation can influence brain wave activity, and hence mental activity, in humans.

The EM field–stress connection

It's no coincidence that many of the less severe symptoms of radio wave sickness—that is, fatigue, irritability, loss of appetite, difficulties in concentration and memory, depression, insomnia, and headaches—are symptoms of chronic stress. The connection between EM field exposure and stress first came to light in the mid-1970s when Soviet scientists discovered that exposing rats even briefly to low-level microwave radiation made the animals release stress hormones. The same reaction was observed with 50 Hz electric fields.

In a 1976 study led by Joseph J. Noval at the Naval Air Development Center in Johnsville, Philadelphia, young adult male rats were exposed for 30 to 40 days to 45 Hz vertical electric fields varying from 100 v/m to 0.1 v/m. The rats were housed in specially equipped, air-conditioned railroad cars, which, being made of metal, shielded the animals from ambient EM fields. Rats kept under identical conditions but not exposed to 45 Hz electric fields acted as the control group.

The exposed rats gained weight some 20 to 30 percent slower than the control rats (even though both groups consumed roughly the same amount of food and water) and had significantly elevated levels of the liver enzyme tryptophan pyrrolase. Elevations in this enzyme can occur in response to various types of stress. Additionally, the brainstems of the exposed rats showed increased levels of the neurotransmitter acetylcholine, which is released by nerve cells in the brain as a consequence of mild stress. The odd thing about the exposed rats is that although they showed signs of being "inwardly" stressed, outwardly they seemed fine, behaving exactly the same as the control rats. All of these details suggest that the animals underwent subliminal activation of the stress response.

Fight-or-flight

"Stress" is an abused term in that we tend to use it frequently without truly knowing what it means. A good definition of stress is "any environmental or physical pressure that elicits a response from an organism."[19] Stress has both a positive and a negative side. On the one hand, it promotes survival and enables us to adapt quickly to changes in our environment. On the other hand, it can do more harm than good, especially when left unchecked. Your body is hardwired to perceive stressful situations as a threat to its survival; it makes no distinction between real threats, such as finding yourself hanging from the edge of a four-story building, and imaginary threats, such as having a heated argument with your spouse. We respond to stress using instinct rather than logic. Who doesn't feel anxious, if not fearful, when growled at by an aggressive dog, even when the dog is situated behind a sturdy metal fence and clearly poses no threat?

The instant you face a perceived threat your body activates the fight-or-flight response, to prepare you to either confront ("fight") the perceived threat or to flee to safety ("flight"). Central to this ancient survival mechanism is the hypothalamus, which communicates with the rest of the body through the autonomic nervous system (ANS).

The nervous system is made up of two components: the central nervous system (CNS) and the peripheral nervous system (PNS). The CNS consists of the brain and spinal cord and is responsible for coordinating the activity of the entire nervous system. The PNS is the portion of the nervous system that lies outside the brain and spinal cord. Although the ANS is classified as

part of the PNS, it is actually controlled by centers located in the hypothalamus, spinal cord, and brain stem.

The ANS is divided into two components: the sympathetic nervous system (SNS) and the parasympathetic nervous system (PSNS). Together, the PSNS and the ANS regulate involuntary activity in the body, such as heartbeat, digestion, pupil dilation, salivation, perspiration, and respiration. The SNS and the PSNS have contrary roles. Whereas the SNS activates the physiological changes that occur during the fight-or-flight response, the PSNS dampens the fight-or-flight response, calming the body down once the threat has passed. If you like, the SNS is the accelerator pedal and the PSNS the brake.

The first system in the body to be activated by the hypothalamus during the fight-or-flight response is the SNS. The SNS tells the adrenal glands to pump large quantities of the hormones epinephrine (adrenaline) and norepinephrine (noradrenaline) into the bloodstream. The effects brought on by epinephrine and norepinephrine are dramatic: heart rate and blood pressure increase; the pupils dilate to take in as much light as possible; extra oxygen is sent to the brain, increasing alertness; and blood glucose levels increase, providing the body with a massive energy boost.

Next, the hypothalamus activates the second component of the stress response system: the hypothalamic-pituitary-adrenal axis (HPA axis)—so called because it consists of the hypothalamus, the pituitary gland, and the adrenal glands. This triggers the adrenal glands to secrete the steroid hormone cortisol. So as to make more energy available for the emergency at hand, cortisol suppresses the activity of non-essential bodily functions such as digestion and immunity. Once the perceived threat has passed, the PSNS kicks in, returning the body to its pre-stressed state. Epinephrine, norepinephrine, and cortisol levels drop.

Chronic stress versus acute stress

There are essentially two different kinds of stress: acute and chronic. Acute stress is another name for short-term stress. It means the fight-or-flight response was activated and then soon after deactivated. Undergoing a job interview can bring about acute stress. The stress you experienced during the interview would have vanished the moment the interview ended. Chronic stress, on the other hand, is persistent stress. In the chronically stressed, the fight-or-flight response gets activated so often that it’s more or less continuously switched on.

The curious thing about chronic stress is that it tends to go unnoticed by the sufferer. It remains just outside of your awareness, slowly gnawing away at you. Remember, the fight-or-flight response occurs in the ANS, while the ANS functions on a largely subconscious level. For this reason, the ANS is often equated with the subconscious mind. Of course, short-term activation of the fight-or-flight response (acute stress) is very much a conscious phenomenon. It’s like revving the engine of a car, then turning the engine off. Long-term activation of the fight-or-flight response (chronic stress) is a largely subconscious phenomenon. It’s like leaving the engine idling on high for too long, until eventually the engine burns out.

In the case of chronic stress, it is the second component of the stress response system—the HPA axis—that remains “idling on high.” The primary result is an excess of cortisol in the bloodstream. Sustained high cortisol levels can be extremely harmful to the body, resulting in suppressed immunity, high blood sugar (hyperglycemia), muscle and bone loss, increased weight gain (as a result of food cravings), learning and memory difficulties, insomnia, aches and pains from inflammation, and fatigue and weakness.

Given that elevated cortisol levels weaken the immune system, stress makes you more susceptible to illness. No medical expert would deny this. If you work as a teacher in a high school or university you'd know the incidence of illness generally increases among students immediately following exam time, which is one of the most stressful times of the year for students. Robert Becker eloquently explains the connection between EM fields, stress, and the immune system:

> "It is well-established that exposure to any abnormal electromagnetic field produces a stress response. If the exposure is prolonged, the stress response system becomes exhausted, and the competency of the immune system declines to below normal. In such a state, animals and humans are more susceptible to cancer and infectious diseases."[20]

Earlier we saw evidence of an EM field–induced stress response in Noval's 1976 study involving rats. As you will recall, the exposed rats, although outwardly fine, gained substantially less weight than the control rats (although one would think the rats, if stressed, would have gained rather than lost weight, the symptoms of stress are many and vary from individual to individual) and also had increased levels of the liver enzyme tryptophan pyrrolase and the neurotransmitter acetylcholine, indicating a subliminal stress response in the animals. While it's true the rats in Noval's study didn't become stressed to the point where their immune systems weakened and they became ill, plenty of studies do show a link between EM field exposure and illness, including cancer, and hence support the stress response hypothesis. We'll look at one such study now.

The Arthur Guy study

In a study funded by the United States Air Force School of Medicine to the tune of $4.5 million and conducted at the University of Washington, Seattle, in the early-1980s under the direction of Dr. Arthur Guy, 100 male rats were exposed for 21 hours a day throughout a period of 25 months to pulsed microwaves at 2,450 MHz and approximately 0.5 mW/cm^2. (This is a good deal lower than the 1 mW/cm^2 exposure limit for the general population.) The control group consisted of 100 male rats kept under identical conditions to the experimental group but not exposed to microwave radiation. It was hoped the study would provide much insight into the possible health effects of long term, low level exposure to microwave radiation.

A total of 115 measures of health and behavior were collected as part of the study, including food and water consumption, body mass, and plasma corticosterone levels. In rats, corticosterone is secreted by the adrenal glands in response to stress, this being the equivalent of cortisol in humans. The term "plasma corticosterone" refers to the presence of corticosterone in the blood. Obviously, we would expect stressed rats to show higher plasma corticosterone levels than relaxed rats.

Initially the exposed rats had higher mean corticosterone levels than the unexposed controls; yet for the remainder of the study they had lower mean corticosterone levels than the unexposed controls. So why the initial peak then drop in corticosterone levels? Commenting on this finding in his book *Cross Currents*, Robert Becker says it indicates "that the stress response systems of the experimental [exposed] animals had become exhausted. This result is exactly as expected for a condition of chronic stress."[21]

Further significant differences were noticed between the exposed and unexposed rats. There

were 16 malignant tumors among the exposed rats compared to 4 among the unexposed controls. Of the 16 malignant tumors among the exposed rats, seven were of the endocrine system, with two thyroid, two pituitary, and three adrenal gland tumors. As for benign adrenal tumors—called pheochromocytomas—there were seven among the exposed rats and only one among the controls. In part because the exposed rats had more adrenal tumors than the unexposed rats, the mean adrenal mass of the former was significantly higher than that of the latter.

The highly respected journal *Microwave News* featured an article on Guy's study in its July/August 1984 issue, at which time the results of the study were still under review by Air Force officials. (It wasn't until 1992 that the study was published in a scientific journal.) The article states that "a number of experts found the…data highly suggestive of a link between microwave radiation and cancer, possibly through a stress response."[22] In a 1984 newspaper article, Dr. Samuel Milham, an epidemiologist at the Washington State Department of Health, is quoted as saying that the results of the study point to a "stress response" in the exposed rats. He explained, "It looks like the microwave radiation may have been a tumor promoter. It didn't initiate the cancers, but once some cancer cells got going it promoted growth of the tumors."[23]

There was clearly a higher incidence of cancer and general ill health among the exposed rats compared to the unexposed controls. This fact is confirmed by Guy and his colleagues in their 1992 paper, which states that the "incidence of benign pheochromocytomas of the adrenal medulla was higher in the exposed group than in the controls," and that there was "a near fourfold increase of primary malignancies in the exposed animals…."[24] The paper goes on to declare that the higher incidence of pheochromocytomas is not statistically significant but that the excess of primary malignancies is statistically significant and "provocative."[25] So what did Guy and his colleagues make of this statistically significant and "provocative" result?

"[W]hen this single finding is considered in light of other parameters, it is conjectural whether the statistical difference reflects a true biological influence. The overall results indicate that there are no defintive [sic], biologically significant effects on rats chronically exposed to this form of microwave irradiation."[26]

That the results of the study were explained away and a negative conclusion drawn smacks of outright fraud on the part of those who conducted the study. It is Becker's contention that the study was designed to generate a negative outcome, so as to prove that microwaves are safe, but that it didn't go quite as planned. Becker bases his argument on the fact that the 200 rats used in the study were gnotobiotic—meaning germ and virus free. Being gnotobiotic, the rats had been delivered by caesarian section and housed in a pathogen-free environment. Gnotobiotic animals are extremely expensive to obtain (which partly explains why the experiment cost $4.5 million) and are used by researchers in experiments that require no interference from bacteria and viruses. For obvious reasons, gnotobiotic animals are far less likely to get sick than normal animals.

According to Becker, those who designed the study knew in advance that exposing the animals to microwaves would produce a stress response; and, aware of the compromising effect that stress has on the immune system, chose to use gnotobiotic animals rather than normal animals for no other reason than to "sharply reduce the incidence of cancer and infectious diseases in the exposed animals."[27] He adds: "Considering the extreme stress experienced by the exposed animals, if the animals had been normal (rather than gnotobiotic) the entire experimental group would have died of infection or cancer long before the close of the experiment."[28]

■■■

The only sensible conclusion to draw from the evidence we've examined so far is that low level EM radiation causes harmful biological effects. As frightening as this is, it's valuable to know, because it enables us to take measures to protect ourselves from such effects. One of the most valuable insights we've gained during the course of our investigation is that EM fields produce a stress response. The symptoms of radio wave sickness make perfect sense when seen in terms of chronic stress, and this applies to my own experience with smart meter RF radiation. The reason I felt agitated and that my immune system collapsed clearly stemmed from a case of chronic stress; not stress caused in the normal fashion, but stress induced by the invisible RF field of the smart meter installed in my home. We will now attempt to get to the bottom of why smart meters seem to cause more health problems than cellphones and other common devices that operate in the RF range.

Smart meters

Like cellphones, smart meters are radio transmitters and receivers. Whereas cellphones operate at approximately 2 GHz, smart meters operate in the frequency bands of 902–928 MHz and 2.4–2.48 GHz and on other nearby frequencies. Devices that operate at or near the same frequency as smart meters include Wi-Fi modems, many cordless telephones, baby monitors, remote controlled light switches, and household microwave ovens.

Cellphones and cellular base stations emit a near constant stream of RF radiation. Smart meters, on the other hand, emit RF energy not in a constant fashion but in the form of sharp, extremely brief pulses. Each pulse lasts from 2 to 20 milliseconds. (One millisecond is one thousandth of a second, or 0.001 second.) The rate at which smart meters pulse, as well as the frequency of individual pulses, varies from moment to moment and is impossible to predict. Independent investigators equipped with RF detectors have proven that smart meters are capable of pulsing at a rate that falls in the ELF range.

The author uses a TriField meter to measure the electric field emitted by a computer. Photo courtesy of Louis Proud.

Smart meters are supposed to have very low RF emissions, lower even than cellphones, and to operate well below exposure limits. The Pacific Gas and Electric Company (PG&E) claims that if you were to stand a distance of one foot from a smart meter, the RF radiation would measure only 8.8μW/cm^2. Other official sources cite equally low power density figures for smart

meters. Yet the catch is that these figures (including the one from PG&E) are "time averaged" with respect to a 30 minute period. This means the pulses are averaged over all the time the meter is not pulsing. Expressing power density in a time averaged fashion is deceptive, because doing so "hides" any large spikes in RF that may have occurred during that period.

It's impossible to deny that the RF radiation emitted by smart meters is extremely weak when expressed in a time-averaged fashion. But what about the power density of individual pulses, known as the "peak power density"? Because companies such as PG&E refuse to provide peak power density figures for smart meters, the matter remains uncertain. The only figures available come from unofficial sources, such as independent investigators who have used RF detectors to measure smart meter pulses.

Cindy Sage, a California-based environmental consultant who specializes in EM field health issues, says she was informed by Southern California Edison that their smart meters carry a peak power density of 229 mW/cm^2 at a distance of 8 inches. She commented in a newspaper article, "It's an enormous, short pulse. It goes right through walls and it only stops when it hits something juicy. You become a walking antenna."[29] Quoted in the same article is a "68-year-old retired electrical engineer and self-made radio-frequency expert" named Lloyd Morgan.[30] Morgan says he calculated that the peak power density for PG&E smart meters is approximately 288 mW/cm^2 (which is similar to Sage's estimate).

I should mention in passing that exposure limits for RF radiation with respect to peak power density are immensely higher than those with respect to time averaged power density. Thus, assuming smart meters do emit RF radiation with peak power density levels as high as those claimed by Sage and Morgan, these levels would still fall well below established exposure limits.

In light of what we've discussed, it's easy to see why smart meters are causing so many health complaints among members of the public. That they emit short, sharp pulses of RF radiation is probably what makes them especially harmful compared to other RF devices. The pulsed aspect of smart meter technology is significant, because some evidence suggests that pulsed EM radiation is considerably more harmful than continuous EM radiation. That smart meters are capable of pulsing at a rate that falls in the ELF range is also significant, given what we discussed in the previous chapter about Schumann resonance and human brain waves. They add yet another layer of "electrosmog" to a world already highly polluted with artificial EM radiation, and that in itself is cause for concern.

EM hypersensitivity (EHS)

How much artificial EM radiation will the public be able to tolerate before the percentage of those suffering from radio wave sickness and other EM-related illnesses reaches epidemic proportions? There are indications we're already facing such an epidemic, thanks in part to the recent introduction of smart meters. Earlier I mentioned how a family in Melbourne by the surname of Florio went so far as to abandon their home after a smart meter was installed in their neighbor's home and they started experiencing headaches and insomnia. Another case I mentioned is that of Vic and Rosemary Tredeau, who also abandoned their home due to health problems caused by a smart meter.

The symptoms described by both the Florios and Trudeaus are undoubtedly those of radio wave sickness. There are also cases where exposure to smart meter radiation has led to EHS, a condition similar to radio wave sickness but far more debilitating. One such case involved a

young Melbourne man who worked briefly as a smart meter installer in 2011 and decided to tell his story in the form of an open letter. This letter was posted on the website "Stop Smart Meters Australia" on October 10, 2012, and has since made its way around the Internet. So as to remain anonymous, the man revealed only his initials. I shall call him James.

James says his job was not to install smart meters per se but to fit already installed, live meters with communication cards and aerials. After working in this role for around two months, he began to experience concentration and memory issues accompanied by a feeling of "general fatigue" and "a sense of creeping anxiety."[31] Unable to function in a healthy, efficient capacity, James lost his job. Yet despite no longer working with smart meters, his health problems multiplied to include heart palpitations, poor bladder control, psychosis, muscle cramps, altered perception, eyesight problems, constant tinnitus, and headaches.

At that stage in his life, James was living in a cramped apartment block in the inner suburb of Hawthorn. In close proximity to his bedroom was a powerful Wi-Fi router. After purchasing a new smart phone his symptoms became more acute, to the point where he felt he was "going to die."[32] It soon dawned on James that his symptoms were linked to EM radiation. For example, he noticed he felt considerably better when he switched his cellphone to "flight mode" (so that it didn't emit RF radiation) and eliminated other sources of EM radiation. "I determined that being around any source of RF waves…really anything with a bit of EM radiation would spike my condition and push me back into that horrible state," he commented.[33]

At one point James paid a visit to Newcastle, New South Wales, to spend time with family members. While there, his symptoms more or less vanished, only to reappear as soon as he arrived back in Melbourne. From that point on, James realized he had no other choice but to leave Melbourne altogether and move to a location with lower EM pollution.

Genuine or psychosomatic?

When faced with the question of whether James's condition is real or psychosomatic, the easiest explanation to accept is the latter. A psychosomatic condition is one caused or aggravated by a mental factor such as stress. Illness due to chronic stress is psychosomatic in nature. A skeptic could argue that James found his job as a smart meter installer highly stressful, and that this stress, not the smart meter radiation, was responsible for his becoming ill. They could further argue that James felt better during his holiday in Newcastle because holidays have a relaxing effect on the mind, not because Newcastle, being smaller than Melbourne, has less EM pollution than Melbourne. So, then, is EHS a genuine or psychosomatic condition?

EHS is a relatively new condition, having only really emerged during the 1980s. Those afflicted with EHS find they become ill when exposed to virtually any form of artificial EM radiation, whether it's from a cellphone, a washing machine, or power lines. The symptoms listed by James, which included fatigue, anxiety, concentration and memory difficulties, and heart palpitations, are all typical of EHS. Other common symptoms include dermatological issues, such as redness, tingling, and burning, in addition to digestive disturbances and ringing in the ears.

The only way EHS sufferers are able to gain relief from their symptoms is by minimizing as much as possible their exposure to EM radiation. This might include using EM radiation-emitting devices sparingly or not at all; living in a remote location, one well away from power lines and cellphone base stations, or in a home shielded from EM radiation; and sleeping under a wire-mesh canopy. Some EHS sufferers go so far as to don wire-mesh body suits and face masks

—similar to the kind of apparel worn by beekeepers.

What does the WHO say about EHS? The WHO describes the symptoms of EHS as "non-specific" and "not part of any recognized syndrome."[34] It compares EHS to multiple chemical sensitivity (MCS)—in which a person develops allergy-like symptoms from exposure to chemicals in the environment—and says the symptoms of both conditions "lack apparent toxicological or physiological basis or independent verification."[35] It further says there is "no scientific basis to link EHS symptoms to EMF exposure."[36]

It's not surprising the WHO is unwilling to accept EHS as a medical diagnosis, nor acknowledge its connection to EM field exposure, given its view that "there is no evidence to conclude that exposure to low level [non-ionizing] electromagnetic fields is harmful to human health." The WHO offers little information as to the prevalence of EHS in the general population, but mentions that one survey came up with an estimate of "a few individuals per million."[37] Other, more reliable surveys indicate a much higher prevalence of EHS.

In a 1997 cross-sectional questionnaire survey involving 15,000 men and women between the ages of 19 and 80 in Stockholm County, Sweden, 1.5 percent of the respondents—the majority women in the 60 to 69 year age group—claimed to be hypersensitive to electric or magnetic fields. Also, a much higher percentage of those in the EHS group than those in the non-EHS group reported being intolerant or allergic to food, pollen, amalgam, dental fillings other than amalgam, mold, dust, mite, gluten, nickel, furry animals, and cosmetics.

A similar type of questionnaire survey was carried out in 1998 as part of the California EMF Program. The survey was conducted over the phone and involved 2,072 randomly selected adult Californians, 3.2 percent of whom reported being "allergic or very sensitive to getting near electrical appliances, computers or power lines."[38] It's been suggested that the incidence of EHS among the general population is steadily increasing and might reach as high as 50 percent by the year 2017.

Countering the view of EHS as a psychosomatic condition is the presence of numerous striking similarities between separate EHS cases. Worth mentioning in this regard is the fact that most cases of EHS can be traced back to a specific job or incident that involved heavy exposure to EM radiation. You will recall that James, prior to developing EHS, spent a couple of months working as a smart meter installer, a job that placed him in very close proximity to smart meters and their pulsed RF fields. James himself attributes the job to his developing EHS.

Veronica Ciandre

Toronto resident Veronica Ciandre, a former television and movie hairstylist in her early 50s, also developed EHS as a result of heavy exposure to EM radiation. Ciandre and her teenage daughter used to reside in a top-story apartment overlooking the city. It had been their home for 12 years. They'd lived there comfortably and happily until, in December of 2009, 25 cellphone antennas were installed on the roof of the apartment building. Ten of the antennas were positioned directly on the roof of Ciandre's apartment. Said Ciandre, "So basically each room in my apartment had an antenna on top of it just six feet away."[39]

Not long after the antennas were installed, Ciandre began to feel ill, with symptoms that included "a hissing or buzzing or high pitched ringing" in the ears, numb hands and feet, persistent headaches, dizzy spells lasting for days, short-term memory loss, concentration problems, heart palpitations, and nausea.[40] She also experienced difficulties with static electricity

and would often get “zapped” when she touched ordinary objects such as her bed mattress and home light switches, as well as every time she patted her pet cat. Most troubling of all, she found it impossible to sleep at night on account of a tingling sensation in her body. According to Ciandre, “It felt like I was being plugged into an outlet.”[41]

Ciandre’s daughter, then aged 14, complained of similar symptoms and also developed painful rashes. “[W]e started feeling like we were living in a slow-cooking microwave,” Ciandre commented.[42] Aware that both her health and that of her daughter would continue to suffer if they remained where they were, Ciandre and her daughter abandoned the apartment in February 2010. They spent months “couch surfing” in the homes of friends before Ciandre managed to find them a permanent place to live. Magda Haves of Trent University, Ontario, an expert on the health effects of EM pollution, visited the apartment with an EM field meter and confirmed the presence of high levels of RF radiation.

Ciandre believes the ordeal rendered her EM hypersensitive and was diagnosed as such by Dr. Riina Bray, the environmental health specialist at Toronto’s Women’s College Hospital. In order to limit her exposure to EM radiation, Ciandre’s been forced to make a number of dramatic changes to her lifestyle. She avoids using a cellphone because doing so gives her “strong discomfort and headaches.”[43] In fact, so acute is her sensitivity to EM fields that a cellphone can trigger her symptoms when four or less meters in proximity to her body. Apparently, at the peak of her sensitivity, she could tell when the microwave was on in the next room, or when someone entered the room with a switched-on cellphone.

Like numerous others who suffer from EHS, Ciandre switches off the power in her home before going to bed at night and sleeps under a wire-mesh canopy designed to block out RF radiation. Using a wireless modem is out of the question; she connects to the Internet through the phone line. Although she’d like to move from the city to the country in order to reduce her exposure to EM radiation, the fact that she has a teenage daughter prevents her from doing so. A spokeswoman for the group Citizens 4 Safe Technology, Ciandre strongly believes we “need to change our relationship to technology, starting with reducing our dependency on it.”[44]

Tim Hallam

That EM sensitivity goes hand-in-hand with other sensitivities is nowhere better exemplified than in the case of Tim Hallam, from Leamington Spa, U.K. Hallam’s troubles began when, at the age of 15, he attended a rock concert so loud it left him with ringing ears and the beginning of what would eventually become tinnitus. Ironically, what made the concert loud was not so much the music but the fact that blanks were fired from a pistol held by the singer of the band. His tinnitus became gradually worse as he continued to attend rock concerts without wearing ear protection.

Hallam, now in his mid-30s, didn’t realize he had EHS until, in mid-2012, a flat mate installed a powerful Wi-Fi router in the house; he found the RF radiation such a nuisance he ended up sleeping in the garden. Before moving back into the house, he converted his bedroom into a Faraday cage by lining the surfaces of the room—the door, ceiling, floor, and walls—with tinfoil and hanging wire gauze over the window. To further protect himself from EM radiation, he sleeps in a custom-built silver-coated sleeping bag. Despite being a Cambridge graduate, he drives a supermarket delivery van for a living—a job that better suits his condition than working in an office. Hallam not only has EHS but is also intolerant of lactose and gluten, allergic to wool, and cannot sleep in a carpeted room.

The difference between an allergy and an intolerance

That there is an overlap between EHS, MCS, tinnitus, and various allergies and intolerances makes the matter a very confusing one. So as to bring some much needed clarity to the situation, we need to get our terms straight. First, the term “hypersensitive” means “highly or excessively sensitive” and is also a synonym for “allergy.” Thus, to have EHS means to be highly or excessively sensitive to electromagnetism. Whether this involves an actual allergic response is something we’ll look into in a moment. Another name for EHS is “electro-sensitivity.” In the medical sense, having a sensitivity to something is equivalent to having an intolerance to something, which is not the same as being allergic to something. In this context at least, the terms “sensitivity” and “intolerance” are synonyms.

It’s not unusual for people to say they’re allergic to something when in fact what they have is an intolerance. The most common of all food intolerances is that of lactose, the main sugar present in milk. If you’re lactose intolerant you can’t digest milk because your body lacks the enzyme required to do so, called lactase. Instead of being digested, the sugars end up in the colon, where they ferment to produce gas, causing bloating, nausea, cramps, flatulence, and diarrhea. Food intolerances are far from lethal; I have yet to hear of a case where someone has died of lactose intolerance.

Allergies, on the other hand, can be lethal. The main difference between exposing yourself to something to which you are intolerant and exposing yourself to something to which you are allergic is that the latter involves an immune system response whereas the former is a purely chemical reaction. Substances that cause allergies are called allergens. Typical allergens include pollens, bacteria, lints, drugs, dyes and chemicals, and foods such as milk, eggs, peanuts, fish, and shellfish. Although there are clearly many different types of allergy—some women are even allergic to their partner’s semen—for the time being we’ll focus primarily on food allergies.

In the United States, an estimated 15 million people—almost 5 percent of the population—have food allergies, of whom 9 million are adults and 6 million are children. (Children tend to outgrow food allergies.) In 2008 it was announced that the incidence of food allergy in the United States had doubled in the last decade. Why the incidence of food and other types of allergy is on the rise worldwide—particularly in developed countries such as the United States and also in countries undergoing industrial development—has the medical community baffled. The most popular theory, called the “hygiene hypothesis,” blames the phenomenon on better hygiene and hence less exposure to pathogens. The theory states that inadequate exposure in early childhood to pathogens increases one’s susceptibility to allergy by suppressing the natural development of the immune system.

An antigen is a foreign substance that, when introduced into the body, stimulates an immune response. (An allergen is a type of antigen.) A normal immune response results in the production of specific proteins called antibodies to combat the specific antigen. These antibodies bind with the antigen in the manner of a lock and key, either rendering the antigen harmless or causing it to be destroyed. An allergy develops when an innocuous substance—an allergen—is mistakenly identified by the immune system as a threat, so that, upon subsequent exposure to the allergen, the immune system responds to the allergen as if it were an actual threat. It is an abnormal reaction of the immune system—abnormal because the substance to which it is reacting is in fact not a threat.

In the case of an allergic reaction, the immune system produces antibodies called Immunoglobulin E (IgE) to combat the mistaken threat. The IgE antibodies travel to cells that

release chemicals such as histamine. It is histamine that causes most of the well-known symptoms of an allergic reaction, such as a runny nose, watery eyes, breathing difficulties, and tissue swelling. Other typical allergy symptoms include vomiting, nausea, and diarrhea. Anaphylactic shock, or anaphylaxis, is a sudden and severe allergic reaction characterized by a sudden drop in blood pressure and breathing difficulties, which, if left untreated, can lead to death within minutes.

When anaphylaxis occurs due to food allergy, peanuts are often to blame. In 2013, a 13-year-old peanut allergy sufferer named Natalie Giorgi died from anaphylaxis while on holiday with her family at Camp Sacramento, California, after biting into a Rice Krispie's Treat that contained peanuts. She spat out the food the moment she realized it contained peanuts, then immediately reported the incident to her mother, who gave her an antihistamine and kept her under observation. Natalie seemed fine until some 20 minutes later, when she began to vomit and had difficulty breathing. Natalie was then administered a series of epinephrine injections. (Epinephrine counters the symptoms of anaphylaxis by stimulating the heart, increasing blood pressure, improving breathing, and so forth.) Yet the injections had no effect; before long Natalie was dead. The case highlights the fact that severe allergic reactions can be lethal even when treated in the appropriate manner. As an interesting aside, it's been calculated that in those highly sensitive to peanuts, a reaction can be triggered by as little as 1/2000th of a single peanut.

Multiple chemical sensitivity (MCS)

Now that we've sorted out the difference between an allergy and an intolerance, it's time we took a brief look at MCS. Those afflicted with MCS exhibit an allergy-like reaction—with symptoms that typically include headache, fatigue, weakness, difficulty concentrating, short-term memory loss, dizziness, irritability and depression, itching, and numbness—every time they're exposed, even in very small doses, to one or more usually harmless pollutants. Such pollutants might include petrol fumes, paint fumes, cigarette smoke, perfumes, and detergents.

Usually their sensitivity can be traced back to a single high dose exposure to a certain pollutant. Because there is no known mechanism that could cause MCS—as distinct from a "true" allergic reaction, in which the mechanism involved is well-understood—most physicians consider the condition to be psychosomatic. MCS and EHS overlap in the sense that many of those who suffer from one also suffer from the other. You will recall that Hallam is hypersensitive to carpet, in addition to suffering from EHS.

Tinnitus and the microwave auditory effect

Earlier we came across evidence of a connection between both EHS and tinnitus and radio wave sickness and tinnitus. Tinnitus is a ringing, roaring, buzzing, whistling, or humming sound in the ears that has no external cause. It is a symptom of a problem with the auditory system, rather than a condition in its own right. In a 2009 German study, the prevalence of tinnitus among a group of 89 EHS sufferers was compared to that among a control group of 107 people who didn't suffer from EHS. Tinnitus was found to be significantly more common among the EHS group, at 50.72 percent, than among the control group, at 17.5 percent. Concluded those responsible for the study, "An individual vulnerability probably due to an over activated cortical distress network seems to be responsible for, both, electromagnetic hypersensitivity [EHS] and tinnitus."[45]

Both EHS sufferers and radio wave sickness sufferers who experience tinnitus as one of their

symptoms tend to attribute the problem to what's known as the "microwave auditory effect" or "Frey effect." The phenomenon gets its name from the researcher who discovered it, Allan H. Frey, an American biophysicist and neuroscientist. In 1960, while employed at General Electric's Advanced Electronics Center at Cornell University, Frey came in contact with a technician whose job involved measuring the fields of new radars. The technician claimed that certain radar beams induced the perception of sound, and that he himself had experienced the phenomenon at some of the sites where he worked. When Frey paid a visit to one of the sites and stood in the radar beam he discovered the technician wasn't lying; he too heard the microwave-induced sound. Actually, the phenomenon was nothing new; it had been reported by radar technicians ever since World War II yet had not been taken seriously by experts.

Frey conducted an extensive investigation into the microwave auditory effect, even testing the phenomenon on human volunteers by means of an RF transmitter. He obtained positive results with both clinically deaf and normal hearing volunteers, at distances as great as several thousand feet from the transmitter, using pulsed microwaves of 300 to 3,000 MHz at an average power density as low as 400 $\mu W/cm^2$ and a corresponding peak power density of 267 mW/cm^2. He found that, depending on such factors as pulse rate and frequency, the induced sound varied from a "buzz, clicking, hiss, or knocking."[46] All of the volunteers described the sound as being located within the head or just behind the head. Explained Frey, "The sound always seems to come from within or immediately behind the head, no matter how the subject twists or rotates in the RF field."[47]

The cause of the microwave auditory effect has never been conclusively explained. According to the most plausible theory, called the thermoelastic expansion theory, each RF pulse induces minor heating—and therefore slight expansion—of brain tissue, causing a pressure wave to be sent through the skull to the cochlea, where nerve endings are stimulated in the same manner as when a sound is heard in the normal fashion. Technologies that exploit the microwave auditory effect to produce the phenomenon of "voices in the head" have been developed by the military.

It's impossible not to recognize a link between tinnitus and the microwave auditory effect. I wouldn't be surprised if some cases of tinnitus, especially when experienced as a symptom of either radio wave sickness or EHS, are due to the microwave auditory effect.

Immune system involvement in EHS?

More and more evidence is accumulating to suggest that EHS is not only a real condition but that it involves a response on the part of the immune system in a similar fashion to that of a conventional allergic reaction. Robert Becker admits in his book *Cross Currents* that the "mechanisms causing a hypersensitivity to novel electromagnetic fields are unknown." But adds, "it would appear that there is a direct effect upon the nervous system and that the immune system is very likely also involved."[48]

Dr. Riina Bray is one of a growing number of physicians who take EHS seriously. Hers is perhaps the only mainstream medical facility in Canada that regularly treats patients for the condition. In a 2012 *National Post* article, she said she is visited by two or three new patients a week who suffer from all the trademark symptoms of EHS, whereas five years ago no such patients appeared at her clinic. She sees the condition as a major and fast-growing public health issue. She said, "Every year we are getting more and more people coming in. I'm very

concerned, because the stories are very, very compelling… These are not crazy people. There is a huge, huge problem."[49]

Another physician who considers EHS genuine is Dr. William Rae, founder and director of the Environmental Health Center in Dallas, Texas. The Center deals with cases not only of EHS but of other sensitivities such as that of pollen, dust, mite, food, mold, and medication. Rae's willingness to take the condition seriously is justified by the fact that he himself sufferers from it. A former thoracic and cardiovascular surgeon, he says he developed EHS while working around the many EM radiation-emitting devices with which modern operating rooms are equipped.

Dominique Belpomme, a professor of oncology at Paris Descartes University and president of the French Association for Research on Treatment Against Cancer (ARTAC), boldly declared in a 2010 interview, "We know with certainty that electromagnetic hypersensitivity is not psychosomatic."[50] Belpomme and his team at ARTAC have developed a diagnostic method for EHS that encompasses blood tests and Doppler ultrasound. (Doppler ultrasound is used by doctors to evaluate blood flow through major arteries and veins.)

Belpomme has hundreds of patients who suffer from EHS and in 2010 saw "up to 20 new cases each week."[51] He added, "These patients clearly have vascular [blood vessel] disorders in the brain. In addition, our biological tests show that 30 percent of them have high levels of histamine, 50 percent have too much stress proteins, most have low levels of melatonin, and 30 percent have levels of antibodies and proteins that are tell-tale signs of thermal shock and brain damage."[52] Belpomme notes that half of his EHS patients also suffer from MCS and that the two conditions share the same brain abnormalities. That 30 percent of Belpomme's patients have "high levels of histamine" is an interesting finding, given that histamine is produced by the body during an allergic reaction.

Olle Johansson, an associate professor and head of the Experimental Dermatology Unit, Department of Neuroscience, at the Karolinska Institute in Stockholm, Sweden,* is one of the world's leading researchers on the physiology of EHS. (In Sweden EHS is officially recognized as a functional impairment.) Johansson, who's been investigating the impact of artificial EM fields on human health since the early 1980s, places manmade EM fields in the category of an allergen, one that, like other allergens present in the environment, can "disturb immune function through stimulation of various allergic and inflammatory responses…"[53]

Johansson explains that whereas environmental allergens such as dust particles gain access to the body by means of the respiratory tract, artificial EM fields possess the unique ability to penetrate the entire body. He points out that the immune system "has evolved during an enormously long time-span and is constructed to deal with its known enemies," and that its "known enemies" do not include artificial EM fields.[54] After all, life on Earth developed under the influence of the essentially static geomagnetic field and radiation from the Sun, not under the influence of such foreign EM sources as ELF fields from power lines, radio waves, TV signals, radar signals, cellphone microwaves, and so forth. The latter have existed on Earth for less than 100 years and constitute a form of exposure to which the immune system has not had time to adapt and hence is ill-equipped to deal with. (Johansson makes no mention of Schumann resonance signals—another natural EM influence under which life on Earth developed.)

Johansson's research shows that sufferers of EHS react when exposed to EM radiation "in a highly specific way and with a completely correct avoidance reaction."[55] Being a dermatologist, his research relates to the skin. He notes that one of the common symptoms of EHS is facial skin problems—for which he coined the term "screen dermatitis"—consisting of red, burning, itching,

or stinging skin as a result of exposure to EM fields from video display terminals (VDTs), cellphones, and other devices.

The skin is an extremely important part of the immune system in that it acts as an external barrier to infection by pathogens. Mast cells, which constitute part of the immune system and are scattered throughout the connective tissues of the body, including in the skin, release histamine and other substances during inflammation and allergic reactions (a process called degranulation). As I stated earlier, it is histamine that causes many of the well-known symptoms of an allergic reaction, including reddening, itching, and swelling of the skin.

By means of skin biopsies and other tests, Johansson has discovered that those afflicted with EHS exhibit certain alterations in the skin indicative of an allergic reaction. One such alteration is an unusually high number of mast cells. He explained: "In facial skin samples of electrohypersensitive persons, the most common finding is a profound increase of mast cells… [This] may explain the clinical symptoms of itch, pain, edema [tissue swelling] and erythema [redness of the skin]."[56] He commented in relation to this and other findings, "[V]arious biological alterations are present in EHS persons claiming to suffer from exposure to EMF. The alterations are themselves enough to fully explain the EHS symptoms, and the involvement of the immune system is evident."[57]

EHS provocation studies

Those who considered EHS to be a psychosomatic condition are quick to point out that the majority of provocation studies conducted thus far have yielded negative results. A provocation study is one where participants are exposed to a certain substance or "thing" that is claimed to provoke a response or to a sham substance or thing that should provoke no response.

In a typical provocation study concerning EHS, the participant is placed in a room (generally one shielded from external EM fields) and exposed to a series of sham and real EM signals. The signals are presented in a random sequence and the participant is given no indication (is "blind") as to which signal is which. At each step during the study, the participant is asked whether the signal is on (real) or off (sham). If the participant gave more wrong answers than right answers, or just as many right answers as wrong answers, the inference would be that the condition from which they suffer is in no way connected to EM field exposure but is in fact psychosomatic.

Dr. James Rubin of King's College London Institute of Psychiatry has conducted a number of studies that demonstrate, in his view, that EHS is most definitely psychosomatic. In a 2005 study, Rubin and colleagues carried out a meta-analysis of 31 separate provocation experiments concerning EHS, "to assess whether people who report hypersensitivity to weak electromagnetic fields (EMFs) are better at detecting EMF under blind or double-blind conditions than nonhypersensitive individuals, and to test whether they respond to the presence of EMF with increased symptom reporting."[58] The study found "no robust evidence to support the existence of a biophysical hypersensitivity to EMF."[59]

Some have criticized Rubin's research into EHS—including this particular study—by arguing it is biased and aimed at discrediting the phenomenon in order to support the interests of big business and the scientific status quo. It just so happens that the study was funded by the Mobile Telecommunications and Health Research Programme (MTRH), which in turn is funded by the telecommunications industry and the government. That fact alone is enough to make anyone suspicious of the study and Rubin's EHS research in general.

Sadly, the majority of provocation studies thus far conducted into EHS suffer certain flaws in design that prevent the phenomenon from emerging. Some of the studies are flawed in that they don't cater to the fact that many sufferers of EHS respond to specific frequencies or kinds of EM fields only. Others are flawed in that they expect participants to exhibit immediate symptoms to the EM field(s) to which they're exposed, when in fact it can take hours or days for symptoms to manifest. Magda Havas explains: "The researchers assumed that reactions to EMFs are immediate, while there is often a delay between exposure and response. People are not switches that can be turned on and off."[60]

An exceptional study

Of those provocation studies whose results argue strongly against the psychosomatic interpretation of EHS, one in particular stands out as exceptionally thorough and well-designed. The double-blind study, published in *The International Journal of Neuroscience* in 2012, involved one participant: a 35-year-old female physician, whom I shall refer to as Jan. Jan claimed to suffer from all the usual symptoms of EHS, including headaches and sleep disturbances, when in the presence of such EM field-emitting sources as computers, cellphones, and power lines.

The study took place in an environment absent of both noise and interference from uncontrolled EM fields. Jan sat in a wooden chair with her eyes closed and her head positioned between two metal plates (which did not make contact with her body). When switched on, the plates produced a 60 Hz electric field of approximately 300 V/m around Jan's head. Three different modes could be selected for the electric field: sham (off), pulsed (at 10 Hz), and continuous.

In the first of two somatic response experiments, Jan was subjected to 10 periods of sham exposure and 10 periods of pulsed exposure. The periods of exposure were randomly ordered and each lasted 100 seconds. At the end of each period of exposure, Jan was required to answer whether or not the field had been applied and to describe any symptoms she may have felt during that period. The second somatic response experiment followed the exact same procedure as the first, except this time Jan was subjected to 15 periods of exposure: five sham, five continuous, and five pulsed.

The results of the first experiment are extremely thought-provoking. Jan reported mild to pronounced symptoms for each of the 10 periods of pulsed exposure, including "temporary pain," "strong headache," "mild headache," "stiff neck," and "muscle twitch." She reported no symptoms for five of the 10 periods of sham exposure, and only mild symptoms for the remaining five periods. The authors of the study explain: "The subject developed symptoms in association with the presentation of a pulsed electric field significantly more often than could reasonably be explained on the basis of chance."[61]

The results of the second experiment are almost as noteworthy as the first. Jan reported no symptoms for four of the five periods of sham exposure, mild to pronounced symptoms for three of the five periods of continuous exposure, and mild to pronounced symptoms for three of the five periods of pulsed exposure. Perhaps not surprisingly, the pulsed field seemed to have a more noticeable effect on Jan than did the continuous field.

Two separate possibilities occurred to the experimenters: Either Jan was able to consciously perceive the field, making it conceivable that the symptoms she'd reported were psychosomatic in nature and stemmed from a fear that EM fields were harmful, or, she was unable to

consciously perceive the field and hence psychological factors played no role whatsoever in her symptoms. In an experiment designed to determine if she could consciously perceive the field, Jan was subjected to 450 periods of exposure consisting of 150 sham and 300 pulsed. The periods of exposure were randomly ordered and each lasted only 2 seconds. Each period of exposure coincided with the sound of a buzzer. Every time she heard the buzzer, Jan was required to press one of two buttons: YES or NO; YES if she'd had any conscious sensation of the field and NO if she hadn't.

Jan gave a YES response rate of 8.7 percent under pulsed field conditions and a YES response rate of 9.9 percent under sham conditions. Obviously, had she been able to consciously perceive the field, her YES response rate for the former would have been higher than her YES response rate for the latter; she would have sensed when the field was on or off and pushed the appropriate buttons. The conclusion arrived at by the experimenters is that Jan lacked conscious perception of the field and, by implication, her symptoms were not psychosomatic. Their final conclusion is startling: "EMF hypersensitivity can occur as a *bona fide* environmentally inducible neurological syndrome."[62]

■■■

In light of our earlier discovery that human magnetoception is a subconscious ability, it makes perfect sense that Jan responded to the electric field in a subconscious rather than conscious fashion. Now, although it's natural to think of EHS as an illness and a problem, perhaps in some respects it's actually a blessing. With those who have EHS, there is an awareness of being harmed by artificial EM fields, coupled with a compulsion to avoid such harm; whereas the rest of us remain unaware of the harm until it's too late. For example, a member of my family knew a builder who, after years of excessive cellphone use, developed a brain tumor on the same side of his head to where he pressed his phone. He died several months after the diagnosis. Had the man suffered from EHS, so that he'd felt noticeably ill every time he'd used a cellphone, it's likely he would still be alive today.

4 Fire from Heaven

Listed in the *Guinness World Records* is a man by the name of Roy Cleveland Sullivan. Born in Greene County, Virginia, on February 7, 1912, he is recognized as having been struck by lightning more times than any other human being. Incredibly, throughout his 71-year life, Sullivan sustained a total of seven lightning strikes—all without being seriously harmed. It's almost as if lightning was drawn to his body. Sullivan was nicknamed the "Human Lightning Rod," a title unlikely to have amused this very unfortunate man. One well-known photograph of Sullivan shows a figure similar in appearance to the actor Gene Hackman, broad-faced, short-haired, and solidly-built. He is dressed in his park ranger uniform, displaying a lightning-damaged hat. There is, one can tell, a slight hint of sadness in his eyes.

All seven of the lightning strikes to which Sullivan was subjected occurred in adulthood and were officially documented. Yet he claimed he had his first close encounter with lightning as a child. While in a meadow cutting wheat with his father, lightning struck the blade of the scythe he was holding, resulting in the field catching fire. Although unharmed by the incident, whether the electricity made contact with his body remains unknown. Even if Sullivan wasn't struck by the lightning, being at such close range would have rendered him exposed to its powerful EM fields.

Sullivan's long career as a Shenandoah National Park ranger began in 1936. In 1942, he was unlucky enough to be situated in the Miller's Head fire tower at the time of a heavy thunderstorm. Lightning is fond of towers and tall structures in general, and this particular tower was no exception. What's worse, the recently built tower hadn't yet been fitted with a lightning rod. Sullivan said, "It was hit seven or eight times and fire was jumping all over the place, so I decided to bail out. I got just a few feet away from the tower and then, blam! It burned a half-inch strip all the way down my right leg and knocked my big toe off. My boot was full of blood, and it ran out through a hole in the sole."[1]

Roy Cleveland Sullivan dressed in his park ranger uniform. The burn mark on his hat is from one of the seven lightning strikes he sustained to his body. Image courtesy of U.S. Department of the Interior.

Decades later, in July 1969, Sullivan was driving his truck through the park, down a treacherous winding road called Skyline Drive, when Thor decided to target him again. Fortunately for us motorists, a car with its windows closed acts as a crude form of a Faraday cage, in that the thin metal shell of the vehicle offers some protection against the intrusion of EM energy. (The same cannot be said of convertibles, however.) Thus, when a car is struck by lightning, electricity will travel through the metal shell of the vehicle toward the ground, rather than penetrate it. On this occasion, Sullivan was driving with the two front windows rolled down. After deflecting off some nearby trees, the lightning made its way into the cab of his truck, knocking him unconscious and burning off much of his hair, including his eyebrows and eyelashes. Sullivan's life was spared by the fact that his uncontrolled vehicle ground to a halt just before reaching the edge of a cliff.

Lightning strike number three took place in July, 1970, while Sullivan was standing at the edge of his front garden. The bolt of lightning struck a nearby power transformer. From there it jumped across to his left shoulder, knocking him several feet into the air. He sustained only minor burns.

At the time of strike number four in 1972, Sullivan was manning the registration station at the Park's Loft Mountain camping area. One moment it was raining gently, with no sign of a storm in the vicinity. The next moment Sullivan heard a huge clap of thunder—"the loudest thing I ever heard"—and saw "fire bouncing around inside the station." Once his ears had stopped ringing, he became aware of a sizzling sound—his hair was on fire. Sullivan used his jacket to smother the flames. "My head felt so hot, it was terrible. I kept trying to get it under the cold water spigot, but it wouldn't fit and I had to use wet paper towels." After the incident, Sullivan confessed: "I have never been a fearful man. But I have to tell you the truth. When I hear it thunder now, I feel a little shaky."[2]

Convinced that an unseen force was out to destroy him and that the next bolt of lightning would kill him, Sullivan began to exercise extreme caution around thunderstorms. Whenever he was caught in a storm while driving his truck, he'd pull over onto the side of the road and lie

down on the front seat, frozen in fear until the storm had passed. A practical man, he made sure to carry at all times a can of water in the back of his truck, in the event of additional fires resulting from lightning strikes. He believed that, as his nickname implied, lightning honed in on him. “I can be standing in a crowd of people, but it’ll hit me,” he once stated. “I’m just allergic to lightning.”[3]

The can of water came in handy when, on August 7, 1973, lightning struck him for the fifth time, once again setting fire to his hair. “I actually saw the bolt that him me,” he said.[4] Sullivan was out on patrol when the incident occurred. It appeared to Sullivan as though the storm cloud responsible for the lightning had literally pursued him. Apparently, he’d driven away quickly the moment he saw the storm cloud forming, only getting out of his vehicle when he thought he’d successfully outrun it. It was then that the lightning bolt struck him.

Lightning strike number six, which took place the following year, involved what appeared to be another “heat-seeking” storm cloud, this time leaving Sullivan with an injured ankle. The seventh and final strike occurred one Saturday morning in 1977, while Sullivan was fishing in a freshwater pool. After striking the top of his head and singeing his hair, the lightning travelled down his right side, leaving him with burns on his chest and stomach. While stumbling back to his vehicle, Sullivan found himself face-to-face with a bear, which tried to steal trout from his fishing line. But the beast was no match for the hardened outdoorsman; he managed to scare it away by clobbering it with a branch.

Sullivan’s apparent ability to attract lightning had a detrimental effect on his social life. There were times when people, fearing that they too might be struck by lightning, gave him a wide berth. “Naturally people avoided me,” he once said. “For instance, I was walking with the chief ranger one day when lightning struck way off. The chief said, ‘I’ll see you later.’”[5]

On one occasion Sullivan and his wife were hanging out washing in their backyard when a thunderstorm suddenly appeared and a lightning bolt issued from the heavens. Ironically, the lightning struck not Sullivan but his wife. One wonders if the bolt was actually intended for him.

There is a tragic conclusion to the story of Roy Cleveland Sullivan. He died at the age of 71 on September 28, 1983, from an apparently self-inflicted gunshot wound. He left behind his wife, Patricia Morris. His marriage to Patricia, which occurred in 1962 when she was 19 and he 50, was his fourth. Either Sullivan killed himself due to depression caused by marital difficulties with Patricia or he was murdered by Patricia and the crime was successfully concealed by her. The latter possibility is touched upon in a 2013 *Washington Post* article by Tom Dunkel titled “Inside the Life of the Man Known As the ‘Spark Ranger.’” Presumably, too, the fear of undergoing another lightning strike might have helped push him over the edge.

What are the odds?

Sullivan’s case is intriguing because it presents a challenge to orthodox science. How is it possible for a human being to be struck by lightning so many times? Australian scientist and author Dr. Karl Kruszelnicki gives the odds of being struck by lightning in the United States, throughout an 80-year lifespan, as around one in 3,000. Other sources, such as the National Weather Service’s Lightning Safety website, list the odds at around one in 10,000. A statistics professor at George Washington University once calculated that the odds of a person being struck by lightning seven times is 4.15 in 100,000,000,000,000,000,000,000,000,000,000.

Even when we consider that Sullivan’s occupation placed him at greater risk of being struck

by lightning than the average person since it involved spending a great deal of time outdoors, we still have an enormous mystery on our hands. Kruszelnicki, who is a staunch skeptic when it comes to UFOs, psi, and other unexplained phenomena, attempts to solve the mystery as follows: "[I]f the local geography of a landscape funnels thunderstorms down a particular pathway, and you happen to work in that pathway (say, as a park ranger), then you are more likely to be hit by lightning, which is what happened to… Sullivan."[6]

Kruszelnicki is probably right to suggest that Sullivan worked in a pathway for thunderstorm activity. However, he seems to have overlooked the fact that many people work in such pathways yet have never been struck by lightning. Are we to assume that all Shenandoah Park rangers, both past and present, are victims of lightning strike? There is the further overlooked fact that not all of Sullivan's lightning strikes were sustained while inside the Shenandoah National Park. On one occasion he was standing in his own backyard when the lightning bolt struck him. And what about the strike he allegedly sustained as a child?

Clearly, if we wish to account for Sullivan's multiple lightning strikes, we need to examine the mystery from an entirely different perspective. Although Sullivan holds the record for the greatest number of lightning strikes sustained by a human being, there are many cases where people, usually men, have been struck by lightning multiple times. It appears that when a person has been struck by lightning once their chance of being struck by lightning again increases exponentially, the experience having transformed them into a "human lightning rod." We'll look at the evidence for this in the next chapter. But for now let's take a closer look at this mysterious and spectacular force of nature called lightning.

A closer look at lightning

As I write this from my home in Darwin—a city known for its spectacular displays of lightning—the sky outside is reasonably clear and sunny. There are no storm clouds and hence there is no lightning. But there is always a thunderstorm raging somewhere in the world. Would you believe that lightning strikes at a rate of 50 to 100 times a second worldwide? Some areas of the globe are subject to higher thunderstorm activity than others, the highest amount of activity occurring in the tropics. Conversely, there are few thunderstorms to be seen in the north and south poles.

The country with the highest amount of lightning activity is central Africa's the Democratic Republic of the Congo—specifically, in an area of land near the small, remote village of Kifuka, located deep in the eastern mountains, where each year there occurs an average of 158 lightning strikes over each square kilometer. In America, the state with the highest incidence of lightning is Florida. It is the country's lightning capital, with an average of 75 to 105 thunderstorm days per year. Virginia, by comparison, averages 35 to 45 thunderstorm days per year.

Darwin, I'm pleased to say, is Australia's lightning capital, with an average of 80 thunderstorm days per year. The city features a tropical savannah climate, as does the entire northern tip of Australia. Here there are only two seasons: the Wet (from November to April) and the Dry (from May to October). Thunderstorm activity in Darwin is confined to the Wet, peaking at the very onset of the season, the high heat and humidity being perfect ingredients for the production of lightning. During the first few months of the Wet, lightning lights up the sky almost every evening. One thunderstorm in 2002 gave rise to an amazing 1,634 flashes of lightning in the space of just a few hours.

Lightning doesn't occur exclusively as a result of thundercloud (cumulonimbus) activity. There are many sources and varieties of lightning. Snowstorms, sandstorms, volcanoes, very

intense forest fires, and nuclear detonations—all can give rise to lightning. There are even cases in which lightning seems to strike from a clear blue sky. This phenomenon, known as a "bolt from the blue," is made possible by the fact that a bolt of lightning can travel up to 25 miles (40 km) from its point of origin.

Lightning isn't restricted to Earth. It's been detected within the atmospheres of Saturn, Jupiter, and Venus. According to NASA, the thunderstorms of Jupiter, the second largest planet in the solar system, are many times larger than those of earth, "with lightning strikes up to 1,000 times more powerful than terrestrial lightning."[7]

On Earth, lightning produced by a thunderstorm can manifest in a number of different ways. The most common form of lightning is that within a thundercloud, called intra-cloud lightning. The second most common is cloud-to-ground. Also, less often, lightning will occur between one cloud and another cloud or between a cloud and the air. Then of course there is ball lightning, which belongs in a class of its own.

Lightning consists of a huge electrostatic discharge within the atmosphere. A distinction is made between static electricity, static meaning "at rest," and current electricity, which involves the movement of electricity through wires and other conductors. All of the electrical devices in your home, whether they have batteries or operate via the grid, are powered by means of electrical current. When you turn on your flashlight, for example, there is a movement of electrons, negatively charged subatomic particles, through the circuitry of the device. Electrons emanate from the negative pole of the battery, pass through and activate the light bulb (which, being a resistor of sorts, inhibits their movement) and then make their way to the positive pole of the battery. They continue to flow in this manner until the device is switched off or the batteries go dead.

What about static electricity? We all know what it feels like to experience a static shock, such as when you touch clothes that have just been removed from the dryer. Atoms, the building blocks of matter, consist of a positively charged nucleus of protons and neutrons surrounded by a cloud of negatively charged electrons. An atom in its natural, balanced state has an equal number of protons as electrons. It is electrically neutral. However, it's possible for atoms to gain or lose electrons, and thus acquire a negative or positive charge. These are known as ions. An atom with missing electrons has a positive charge; an atom with additional electrons, a negative charge.

Static electricity is all about contact and friction. If you take two insulators of different material and rub them against each other—for example, a glass rod and a silk cloth—electrons are transferred from one to the other. In this case, electrons move from the surface of the glass to the piece of silk, giving the former a positive charge and the latter a negative charge. Being of opposite charge, the two materials will be attracted to each other.

Static charges tend to dissipate slowly. There are times, however, when the charge gets released all at once, in some cases resulting in a visible spark and a minor electric shock. We call this an electrostatic discharge. The "zap" you experience when you touch a metal doorknob on a dry day after walking across a carpeted floor is a perfect example of this phenomenon. It occurs because your body has picked up from the carpet a negative static charge (electrons). The moment contact is made with the doorknob, the electrons jump across from you to the metal (this being an excellent conductor of electricity). The same principle is at work when lightning erupts in the sky, albeit on a much larger scale.

The Leyden jar

The earliest experiments in the study of electricity were all static-based; the battery, which produces a steady electric current, wasn't invented until around 1800. The Leyden jar, the first device capable of storing an electric charge, was discovered by accident in 1745 by the German inventor Ewald Georg von Kleist, and again in 1746 by the Dutch physicist Pieter von Musschenbroek of the University of Leiden (Leyden). That the two men made the same discovery independently of each other, and at roughly the same time, is another of those strange synchronicities in the history of science.

The forerunner of the modern-day capacitor, the Leyden jar consists, in its most common form, of a cylindrical-shaped glass jar, its inner and outer surfaces coated with sheets of metal foil. The glass acts as an insulator between the two surfaces, keeping them separated, while the outer surface is grounded. Connected to the inner surface, and protruding through the mouth of the jar, is a vertical brass rod. A charge is applied to the inner surface, such as through the use of a Van de Graaff generator, inducing an opposite charge on the outer surface. If the device has been charged sufficiently, contact between the brass rod and the outer surface will result in a significant electrostatic discharge.

The renowned polymath Benjamin Franklin (1706–1790) applied his mind to the study of electricity beginning around 1746, using Leyden jars as the basis of many of his experiments. Like some kind of perverted geek, he enjoyed conducting experiments in animal electrocution, zapping his victims with the "electric fluid" of one or more fully-charged Leyden jars. He noticed that animals slaughtered in this fashion had "uncommonly tender" flesh. In December of 1750, he attempted to electrocute a holiday turkey while an audience sat and watched; though on this occasion the experiment went horribly wrong.

Wrote Franklin, in a letter dated December 25, 1750: "I have lately made an experiment in electricity that I desire never to repeat. Two nights ago, being about to kill a turkey by the shock from two large glass jars, containing as much electrical fire as forty common phials, I inadvertently took the whole through my own arms and body…."[8] The audience witnessed a great flash and heard a "crack as loud as a pistol" as Franklin was knocked senseless. Apart from several days of sore muscles and a feeling of great embarrassment, no significant harm resulted from the blunder (although the fate of the turkey remains unknown).

A dangerous experiment

Today, everybody knows that lightning is an electrical phenomenon. During Franklin's time, however, the connection between lightning and electricity was uncertain; the matter awaited proper scientific investigation. Franklin, writing in 1749, listed a number of similarities between the two phenomena: that they both are "conducted by metals"; that they both have a "crooked direction"; that they both subsist in water or ice; that they both give a "sulphurous smell"; and that they both are capable of "destroying animals."[9] If, Franklin reasoned, thunderclouds are electrically charged, then lightning must be an electrical phenomenon. But how does one test whether thunderclouds are electrically charged? Sure enough, in July 1750, Franklin devised an experiment that would enable him to do just that:

> "On the top of some high tower or steeple place a kind of sentry box…big enough to contain a man and an electrical stand [an insulator]. From the middle of the stand let an iron rod rise and pass bending out of the door, and then upright twenty or thirty feet,

pointed very sharply at the end. If the electrical stand be kept clean and dry, a man standing on it when such clouds are passing low might be electrified and afford sparks, the rod drawing fire to him from the cloud."[10]

Benjamin Franklin's famous kite experiment. Image courtesy of Wikimedia Commons.

To classify Franklin's proposed experiment as dangerous would be putting it mildly. For, in the event of a direct lightning strike, the person holding the rod would either be killed or seriously injured. No doubt oblivious to such danger, a Frenchman by the name of Thomas-Francois Dalibard successfully carried out the experiment in May 1752, obtaining sparks from the iron rod while a thunderstorm was active above him. It wasn't long before the experiment had been successfully replicated by others, proving beyond all reasonable doubt that thunderstorms are electrical in nature.

Franklin's famous kite experiment was performed in June 1752. A variation on his July 1750 experiment, the kite served the same function as the iron rod; the mobility of a kite, coupled with its ability to reach a high elevation, made it a superior alternative. We are told that the kite flown by Franklin was tethered by a piece of twine, which, being damp, was electrically conductive. Tied to the end of this was a key, and beyond that a length of insulating silk ribbon.

It is reported that, as he held onto the silk ribbon, Franklin saw sparks jump the short gap from the knuckles of his hand to the key, thereby demonstrating that thunderclouds are electrically charged and, ergo, that lightning is an electrical phenomenon. Franklin is said to have captured some of this atmospheric electricity in a Leyden jar. It's fortunate he wasn't killed or seriously injured while conducting the experiment, which would have been the result had his kite been struck by lightning. Indeed, people have died trying to imitate the experiment.

Death by ball lightning

One early pioneer of lightning research who unfortunately did lose his life while trying to replicate one of Franklin's experiments was Georg Wilhelm Richmann, a Swedish physicist living in St. Petersburg, Russia. At his home, Richmann had set up near a window an apparatus consisting of an experimental rod connected to an "electrical indicator," which he hoped to observe as soon as a thunderstorm appeared. On the day of the tragic event, August 6, 1753, Richmann was attending a meeting at the Russian Imperial Academy when, having noticed a thunderstorm in the area, he rushed home as quickly as he could, accompanied by his engraver, Sokolov. Richmann is said to have stood about a foot away from the iron rod while leaning over the electrical indicator. The thunderstorm was still some distance away, suggesting little danger with regard to the possibility of a lightning strike. What occurred next was extremely unexpected: "[A] palish blue ball of fire, as big as a fist, came out of the rod without any contact whatsoever. It went right to the forehead of the professor, who in that instant fell back without uttering a sound."[11]

To have witnessed the event as Sokolov did must have been truly mind-blowing in the most unpleasant sense. The lightning that struck and killed Richmann was no conventional form of lightning, but rather ball lightning. Curiously, there was found on the physicist's forehead, where the lightning had made contact, a single red spot, "from which spurted some drops of blood through the pores, without wounding the surrounding skin." What's more, "the shoe belonging to his left foot was burst open."[12]

The death of Georg Wilhelm Richmann. Image courtesy of Wikimedia Commons.

I should mention that it's not uncommon for lightning strike victims to be left with missing or damaged shoes, resulting from when the sweat on their feet is instantaneously turned to steam from the intense yet short-lived heat of the strike. Their shoes are literally blown off or blown apart. Other items of clothing can be damaged in the same way.

Franklin's lightning rod

Also in 1752, not long after his kite experiment, Franklin constructed the world's first lightning rod, which he attached to the chimney of his house in Philadelphia. The rod was made of iron and had a sharp, pointed tip—pointed because Franklin had earlier observed that "electric fluid is attracted by points."[13] (Electric lines of force are more highly concentrated around pointed objects.) It was connected to the ground via an insulated wire running down the stairwell to an iron water pump. Franklin had discovered a simple yet ingenious way to protect buildings, ships, and other structures from being struck by lightning, the rod serving to route the lightning harmlessly to ground.

Lightning striking the Eiffel Tower on June 3, 1902. Photo courtesy of National Oceanic and Atmospheric Administration.

Using the lightning rod attached to his roof, Franklin installed in his home a kind of thunderstorm detection system. Whenever the rod was "activated" by a thunderstorm passing overhead, a small brass ball suspended by a silk thread would play between two bells, causing them to tinkle loudly.

Despite some opposition from Christian authorities, who felt that the new devices interfered with the will of God, the lightning rod proved popular and many were installed. In 1752 alone, both the Academy of Pennsylvania (later the University of Pennsylvania) and the Pennsylvania

State House (later Independence Hall) were fitted with lightning rods. Today, lightning rods are a common sight on the tops of tall buildings—just take a look at the nearest church tower.

Having a lightning rod fitted to a building means that, if it happens to be targeted by lightning, there's a good chance the lightning will strike the rod as opposed to the building itself. If a lightning rod is to function properly by diverting lightning away from the structure it's intended to protect, the tip of the rod must exceed the height of the structure in question. Lightning rods provide a 45-degree angle "cone of protection."

How a lightning rod works is simple. Lightning always chooses the path of least resistance. This means selecting a tall object in preference to a short object—in this case the lightning rod sticking above the house rather than the house itself. It also means selecting a conductor in preference to an insulator. Whereas insulators (such as wood and rubber) do not easily permit the flow of electric current, conductors (all metals) carry electric current with ease. A tall metal rod with a direct connection to ground makes an ideal conductor.

Tall buildings aren't the only manmade objects for which lightning has a strong affinity. It's common for planes (and other airborne objects) to be struck by lightning. Usually when this happens the plane isn't struck by lightning per se but triggers the lightning as it passes through a heavily charged region of a cloud.

On average, a commercial aircraft will be struck by lightning once in every 5,000 to 10,000 hours of flying time, according to the Federal Aviation Administration (FAA). This is equivalent to around once a year. Thankfully, modern planes are designed in such a way as to be almost completely impervious to severe lightning damage. Generally, the damage sustained consists of nothing more than a pit mark or burn mark on the aircraft's metallic shell (which, like that of a car, behaves as a crude form of a Faraday cage). It's reassuring to know that the last civilian plane crash in the United States directly attributed to lightning was in 1967, the lightning having triggered a fuel tank explosion.

Plasma: the fourth state of matter

Earlier we established that lightning is a huge electrostatic discharge, no different in nature to the tiny spark that jumps from your finger to a metal doorknob, giving you a minor shock. In this example, an electrostatic discharge is produced when, due to the presence of an electric field between your finger and the doorknob, the air between the two "breaks down" (undergoes ionization). Ionized air, also known as plasma, is air that has been stripped of its electrons. Since plasma is an electrically conductive medium, it allows the electrons to flow from your finger to the doorknob.

Whenever we think of matter in its various states, the terms "solid," "liquid," and "gas" immediately spring to mind. There is, however, a fourth state of matter: plasma. It is estimated that more than 99 percent of matter in the universe exists in the plasma state. Our very own Sun is a big ball of plasma.

In the plasma state, positively charged ions and their detached electrons are able to move freely about. It is these free electrons that enable the medium to conduct electricity. In order for a substance to conduct electricity it must contain mobile particles that are capable of carrying charge, such as electrons. Copper and other metals make excellent conductors of electricity because in them electrons are loosely attached and able to move easily from one atom to the next. Plasma is considered an electrically neutral medium, with an overall charge of zero, since

the positively and negatively charged particles of which it consists are roughly equal in number.

Those beautiful heavenly displays seen at high latitudes, known in the Northern Hemisphere as the aurora borealis (northern lights) and in the Southern Hemisphere as the aurora australis (southern lights), are produced when particles from the solar wind are captured by the Earth's magnetic field and funneled downward toward the poles, where they collide with oxygen and nitrogen atoms in the upper atmosphere. The oxygen and nitrogen atoms, having lost electrons as a result of such contact, become ionized, emitting photons (light). The most impressive auroral displays occur during periods of high solar activity.

Auroral displays and lightning are two forms of plasma that exist naturally on the planet. Special conditions such as very high temperatures are required for the formation and sustainment of plasmas. A scarcity of such conditions on Earth means that naturally occurring plasmas are a rare phenomenon. Artificially produced plasmas, on the other hand, are extremely common. They exist all around us in the form of fluorescent lights, neon signs, plasma TVs, welding arcs, and plasma balls.

The intricacies of lightning

The reason lightning takes place is due to an imbalance of electric charge. We have a surplus of energy on one side and a lack of energy on the other, which amounts to a state of tension. In nature, an imbalance always seeks to correct itself, to achieve equilibrium and so relieve the accumulated tension. The mechanisms by which storm clouds build up the charge required to produce lightning are not yet fully understood by scientists.

One compelling theory states that when ice crystals and graupel particles (soft hail) within the cloud collide, the former acquire a positive charge and the latter a negative charge. The positively charged ice crystals, being smaller and lighter, find their way to the top of the cloud, while the negatively charged graupel particles, being larger and heavier, find their way to the bottom of the cloud. The result is a charge separation, whereby the lower portion of the cloud is negative and the upper portion positive. The greater the charge separation, the better the chance that lightning will manifest.

The strong negative charge at the base of the storm cloud acts on electrons in the ground directly below it, repelling them. The ground thus acquires a strong positive charge, whereas before it was negatively charged. This induced ground charge stays with the cloud as it moves along, much like a shadow. We now have a charge separation—and hence a powerful electric field—between the negatively charged base of the cloud and the positively charged ground below. This electric field causes the surrounding air to break down, such that there appears many separate paths of ionized air (plasma) stemming from the cloud. Called stepped leaders, they propagate toward the ground at an average velocity of 1.5 times 10^5 meters per second (one two-thousandth the speed of light), moving not in a straight line but in zigzagging steps, with intervals of 10 to 50 microseconds between each step. Stepped leaders are faint luminous branches that "grow" from the sky. Their job is to "burn a path in the air" for the lightning to follow.

Let's imagine a storm cloud with three stepped leaders stemming from its base, each one "pulsing" closer and closer toward the ground. One of the leaders—"leader x"—has almost reached the ground, while the others lag far behind. Since the ground beneath the cloud has a strong positive charge, it is only natural that, as the negatively charged leaders draw closer, objects on the ground would want to "reach out" and connect with them. The way objects do this

is by sending out an upward-moving spark, around 10 to 90 meters in length, called a positive streamer. Although positive streamers are more likely to be initiated by tall, pointed objects like buildings and trees, literally any object can send out such a spark—even a person. When a stepped leader and a positive streamer unite, the pathway between cloud and ground is complete and current is free to flow. In this example, leader x has united with the positive streamer of a church steeple; the others have failed to make such a connection.

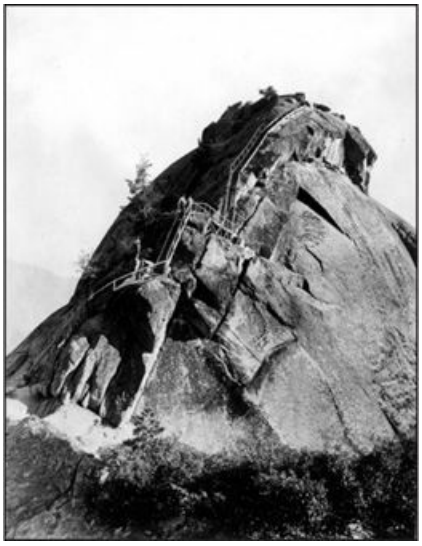
What we perceive as lightning is not the stepped leader, but rather the current that flows along the pathway created when a stepped leader and a positive streamer unite. Called the return stroke, this beautiful, bright flash of electrical current is only a few hundred microseconds in duration. So quick is the interval between the appearance of the faint stepped leader and subsequent appearance of the bright return stroke that the former cannot be perceived.

If you were to videotape a single incident of lightning and play it back at a very slow speed, you would find that what actually took place was a return stroke followed by a rapid succession of additional return strokes that all followed the same path. These are known as secondary strikes. A single incident of lightning can consist of anywhere between one and, say, 20 return strokes; the average is three or four. Generally, lightning events that consist of multiple strokes have a flickering appearance, as the individual strokes are spaced just far apart enough for our eyes to distinguish them.

An enormous amount of energy

Lightning carries an enormous amount of energy. The potential difference between cloud and ground is around 10 to 100 million volts, while the return stroke current has an average peak value of 30,000 A, although it can reach as high as 200,000 A. When a high amount of electric current flows through an imperfect conductor—be it a length of wire or a channel of plasma—there's a good chance the conductor will be heated as a result, an effect known as resistive heating. (There is no such thing as a perfect conductor.) Due to resistive heating, the peak temperature of the return stroke is on the order of 30,000 degrees Celsius (50,000 degrees Fahrenheit)—roughly five times hotter than the surface of the Sun. It is this heat that accounts for the brilliant glow of the return stroke, as well as for the production of thunder. As lightning instantly heats the air through which it passes, the air is forced to expand very rapidly, creating a shockwave audible as thunder.

Since light travels at about 300,000,000 meters per second, whereas the speed of sound through air is much slower, at around 340 meters per second, thunder is always heard after the lightning strike that produced it. By counting the number of seconds between a stroke of lightning and its associated thunder, then dividing the number of seconds by five, you end up with a rough idea of how far away (in miles) the lightning is. If you were to experience lightning in your immediate vicinity, the resultant thunder would be almost instantaneous, not to mention extremely loud and terrifying. What would be heard is an earth-shattering bang of around 120 decibels (dB), which is loud enough to cause temporary deafness. Because thunder is a shockwave, it is capable of causing damage to buildings and other structures within close range, cracking windows and the like.



Steps leading to the summit of Moro Rock at Sequoia National Park. Image courtesy of U.S. Geological Survey.

The spark of life

In one sense, lightning is a wholly troublesome and undesirable phenomenon, which, like ticks, tooth decay, and car crashes, we would be better off without. It downs planes (or used to); sparks destructive forest fires; damages sensitive electrical equipment; scares pets and old ladies senseless; and occasionally targets people, not all of whom survive. Every year in the United States, lightning kills an average of 73 people and injures many hundreds. It is responsible for more fatalities than tornadoes and hurricanes (though less than flash floods). It easily ranks as one of the most hazardous weather-related phenomena on the planet. But as dangerous, frightening, and destructive as lightning is, it has numerous positive qualities as well. Its beauty, for example, is difficult to deny. More significantly, it serves a number of crucial functions in nature.

I once heard someone say that plants grow better after a thunderstorm. Though this is a spurious statement, it does contain a grain of truth. For you see, lightning aids the growth of plants by contributing to the process of nitrogen fixation, whereby free (or atmospheric) nitrogen —which makes up 78 percent of the air we breathe—is combined with other elements to form useful nitrogen compounds like ammonia, which plants require in order to grow.

Some scientists have gone so far as to suggest that without lightning, life may never have originated on Earth. According to this view, lightning was the “spark of life” that kicked the “primordial soup” into action, transforming inorganic matter into amino acids, which eventually combined to create living organisms.

The idea is a potent one and conjures up images similar to those found in Mary Shelly’s classic novel *Frankenstein*; or, *The Modern Prometheus* (1818). As those familiar with the story will know, Dr. Victor Frankenstein’s monster, which he builds in his laboratory from pieces of corpses, is brought to life by means of electricity (at the time believed to be the “life force” itself). In many of the Frankenstein movies, the electricity used to animate the dead creature is harnessed directly from a lightning bolt, the bolt captured by a rod or tower mounted to the roof of the mad scientist’s laboratory.

The global electric circuit

While it's easy to think of lightning as an isolated phenomenon, nothing could be further from the truth. It is simply one aspect of a huge electrical system that encompasses the entire globe, called the global electric circuit. The atmosphere, far from being electrically active only when a thunderstorm is present, is constantly electrically active—even on a clear, sunny day. For you see, the Earth is like a giant capacitor, with the ionosphere being the positive "plate" and the ground the negative "plate." The voltage difference between them is around 200,000 to 500,000 volts. This gives rise to what scientists refer to as the "fair weather electric field."

Whereas in the case of cloud-to-ground lightning, the direction of current flow is upward (from the ground to the atmosphere), the fair weather electric field has the opposite effect, producing a downward flow of current (from the atmosphere to the ground) of approximately 1,000 A. Expressed another way, lightning carries electrons to the ground, giving the Earth a negative charge, while the fair weather field carries electrons away from the ground, depleting the Earth's negative charge. The role of lightning, then, is to maintain balance of the global electric circuit. Martin Uman explains, "Thunderstorms act as batteries to keep the Earth charged negatively and the atmosphere charged positively."[14]

Despite our being almost constantly immersed in the fair weather electric field of the earth, we fail to notice it. But why? The main reason is that almost everything, including the human body, is a good conductor compared to air (which is in fact classified as an insulator). Our bodies have no difficulty "shorting out" this field. What's more, the current associated with the fair weather field is distributed across the entire surface of the planet, so that locally it is very weak.

"A Hair Raising Experience on Moro Rock"

While working on this chapter, I was browsing the internet for lightning-related images when one particular image—an old photo—caught my attention. Taken on August 20, 1975, it shows two brothers standing side by side on what appears to be a cliff or mountain top, the sky hazy with rain and filled with ominous storm clouds. The youngest, on the left, has short, sandy-colored hair. The other is roughly a foot taller and has dark hair down to his shoulders. In both cases their hair is standing on end, indicating the influence of a powerful electrostatic field. Clearly amused by the phenomenon yet unaware of the danger they're in, the brothers are sporting beaming smiles.

The photo appeared in the 1995 Weather Whys and Wonders Calendar and is also featured on the National Oceanic and Atmospheric Administration (NOAA) website. There is a fascinating story behind the photo. It's a story you ought to bear in mind when you next find yourself in the middle of a thunderstorm. It could even save your life.

The eldest brother, Michael McQuilken, born in 1957 in San Diego, California, is today a software engineer and professional drummer. In a 2013 article titled "A Hair Raising Experience on Moro Rock," Michael describes exactly what happened to him and his younger brother Sean on that fateful day in August of 1975. Michael, then aged 17, was on a camping trip with his family in Sequoia National Park. Sean was 12 at the time. Located in California's spectacular Sierra Nevada, the Park features some amazing hiking trails, one of which leads to the summit of Moro Rock, a huge, dome-shaped granite monolith.

Michael, accompanied by Sean, his other brother Jeff, his sister Mary, and her friend Margie, had taken the trail to the summit of Moro Rock despite the poor weather. After spending a

moment enjoying the view, it became apparent that everyone's hair was standing on end. Michael recalls, "Everyone was in a jovial mood, even laughing, at the sight of our hair sticking up." This was when the famous photo was taken, with Mary acting as photographer. Michael says he was wearing a ring on his right hand and that when he raised his hand in the air the ring "began to buzz so loudly that everyone could hear it."[15] The hikers were blissfully unaware of the fact that they happened to be standing in a powerful electrostatic field and were therefore in grave danger of being struck by lightning.

All of a sudden the temperature dropped and it began to hail, prompting the group to return down the trail. Michael was second in line and Sean first in line. They were about halfway down to the bottom when Michael found himself "immersed in the brightest light I have ever seen." He continues: "The next part is strange. I distinctly remember feeling weightless, and that my feet were no longer touching the ground…it felt like a number of seconds transpired, even though I realize that lightning strikes are instantaneous."[16]

Next came a "deafening explosion" of thunder, and Michael found himself lying on the ground, the others lying beside him. It was discovered that lightning had struck not the entire group but a single member of the group: Sean. He was found "huddled on his knees" with "smoke pouring from his back," but fortunately still had a pulse and was breathing.[17] Michael picked up his injured brother and began to carry him down to the parking lot. The others followed.

The "hair-raising" photo of Michael McQuilken (right) and his brother Sean (left) on the summit of Moro Rock. Copyright © 1975 by Michael McQuilken. The photograph cannot be published or posted anywhere without written consent from Michael McQuilken (www.michaelmcquilken.com).

When the group reached the parking lot, they encountered a woman struggling desperately to revive her husband. He, too, had been struck by lightning. Named Lawrence Brady, he had a burn mark near his heart and was turning blue from lack of oxygen. Michael helped the woman administer CPR as they waited for paramedics to arrive. Sadly, however, Brady didn't survive. It later came to light that two other men had been targeted by lightning. One of the victims had his shoe blown off. The other, who'd been taking photographs at the top of Moro Rock at the time the lightning struck, was badly injured; he ended up in a coma for about six months. Not only

had the lightning blown his camera to smithereens, it had almost entirely disintegrated his clothing.

Sean's injuries consisted of third-degree burns to his back and elbows. Michael had been standing in close proximity to Sean at the time the lightning bolt hit. He was far enough away from the lightning bolt for it not to make contact with his body, though close enough to be affected by its powerful EM fields—hence his experience of weightlessness and time slowing down. The others, being farther away, were knocked to the ground but didn't experience any immediate effects from the strike.

Michael speculates that the lightning jumped from Sean to a nearby metal handrail, travelling down to Brady, then further down still to a stone and concrete drinking fountain located in the parking lot. The drinking fountain, which exploded, happened to be positioned directly in front of where his parents sat waiting in their truck. He suggests that the conductive handrail, having "captured" the lightning in a similar manner to that of a lightning rod, prevented Sean from receiving the full impact of the strike and therefore saved his life.

Michael says he's been asked numerous times by others whether his encounter with lightning changed him in a fundamental way, such as by endowing him with "superpowers." He denies having gained any remarkable abilities, but confesses that since the incident he's "always had a lot of energy…." He elaborates: "A decade of my life was spent writing software, practicing drums for three to four hours a day, teaching up to 38 students, and performing, recording, or rehearsing all in the same day." Furthermore, he attributes spiritual significance to his experience of weightlessness and time slowing down, and feels that it "helped to set up the sequence of events that led to my discipline of meditation."[18]

Curious to know what became of Sean and the other members of the group, I got in touch with Michael via email in mid-2014. What he revealed to me was heartbreaking, to say the least:

> "Sean was the one who grounded the most and experienced third-degree burns on his rear belt line and elbows. I was next to him and had the strange sense of time dilation. Mary was behind me and her skin turned a green color for about 10 hours and was accompanied by vomiting. Jeff was behind Mary, and Margie was behind Jeff. Jeff took his life in 1987. Sean took his life in 1989. Margie, who had always been a happy person, began experiencing periods of depression after the strike. Mary had a 7.5 cm meningioma surgically removed last August. It was the type that grew so slowly that the doctors said that it had to have started when she was 15 or 16 years old. I seem to be the only one that didn't experience any negative effects from the strike."[19]

The lightning desperation position

Quite a few people have experienced the effect of having their hair stand on end from a thunderstorm-induced electric charge. If you're standing directly beneath a storm cloud and you happen to be the tallest object around, chances are this will happen to you. You might even find your plastic raincoat beginning to lift up into the air, feel your skin tingle, smell ozone, hear "buzzing" or "crackling" noises around you, or, as happened to Michael, notice your metal jewelry begin to "hum." All of these phenomena indicate that lightning could strike you any second. If the electric field is especially strong, it generally means that a positive streamer is reaching up from the top of your head, urging to be united with a stepped leader zigzagging down from the cloud.

A strong atmospheric electric field has the potential to cause pointed objects, such as church spires, masts of ships, and airplane propellers and wingtips, to emit a corona discharge. This faint, bluish-white plasma is known as St. Elmo's fire and is sometimes accompanied by a crackling or hissing noise. It was named after St. Erasmus of Formia (also called St. Elmo), the patron saint of sailors, due to it often being spotted around the masts of ships by sailors out at sea. As it tends to manifest toward the end of a storm, they considered it a good omen. It would be rather more sensible, however, to associate St. Elmo's fire with bad luck rather than good. After all, it can only form in the presence of a strong atmospheric electric field, such as that caused by a thunderstorm; it can therefore indicate that lightning is about to strike.

If you find yourself caught in the middle of a thunderstorm, you can do one of two things to reduce the danger of being struck by lightning: (1) run for shelter (provided it's available); or (2) assume the "lightning desperation position." The latter consists of crouching down on the balls of your feet, while keeping them as close together as possible so as to prevent the electricity from travelling through one leg and out the other. It's important to make sure that no other part of your body makes contact with the ground. You should also place your hands over your ears, as thunder at close range can cause significant hearing damage. According to the NOAA, "there has never been a documented case of somebody being injured or killed while in the lightning desperation position."[20]

5 Transformed by Lightning

In the 2009 sci-fi thriller film *The Box*, written and directed by Richard Kelly and based on the 1970 short story "Button, Button" by Richard Matheson, the subject of lightning strike injury is exploited to great artistic effect. The story, set in 1976, begins with the early morning arrival of a mysterious package on the doorstep of Virginia couple Norma (Cameron Diaz), a school teacher, and Arthur Lewis (James Marsden), a NASA engineer. Inside the package is a box-shaped device with a single red button on the top, accompanied by a note that reads: "Mr. Steward will call upon you at 5 pm."[1] Access to the button can only be achieved by means of a key, which is missing.

Mr. Steward (Frank Langella), a middle-aged man in a dark suit and homburg hat, arrives at the Lewis residence at the appointed time. He bears on the left side of his face a large, cavernous burn. Mr. Steward hands Norma the key to the device and tells her if she presses the button two things will happen: First, she will receive one million dollars in cash, and second, "someone, somewhere in the world, whom you don't know, will die."[2] He gives her 24 hours to decide whether or not to press the button. Overcome by curiosity and tempted by the possibility of receiving a million dollars, Norma presses the button. This sets into motion a series of strange and disturbing events involving murder, teleportation, and a top-secret conspiracy of cosmic origin.

We eventually discover that the enigmatic Mr. Steward is an employee with the National Security Agency (NSA), and that the device he presented to the Lewises is part of an experiment, undertaken by "those who control the lightning," to assess human morality.[3] It turns out other families besides the Lewises have been presented with identical devices and thus involuntarily recruited as subjects in the bizarre experiment. Mr. Steward, we further discover, is not a normal human being but rather "something else."[4] He was struck and killed by lightning—hence his facial disfigurement—but then miraculously came back to life, whereupon he was transferred to a top secret military hospital. At the hospital doctors found Mr. Steward had acquired "some extraordinary capabilities."[5] In particular, his body healed "at a rate 10 times quicker than normal."[6]

Later in the movie Mr. Steward reveals that since being struck by lightning he has been "in communication with those who control the lightning."[7] Although the audience never discovers who "those who control the lightning" are, the inference is that they're god-like extraterrestrial, or extra-dimensional beings.

As a result of being struck by lightning, Mr. Steward is transformed from an ordinary man into "something else." Either his body is taken over by "those who control the lightning," which would make him a man possessed by a god, or—more likely—he is transformed into an intermediary between humanity and the gods, which would place him in the category of a demigod or shaman. Whichever the case, Mr. Steward is struck by lightning, dies, and comes back to life a transformed man—a man who possesses the remarkable ability to communicate with a "higher power" and in so doing control the fate of humanity.

It's a stretch to think that a person could be transformed into some kind of higher being as a consequence of being struck by lightning, as happens to the character Mr. Steward in *The Box*. It is, after all, a work of science fiction. And yet, as we shall see, some of the effects experienced by lightning strike survivors are strange and highly extraordinary indeed. For now, let's take a look at a number of typical cases of people who were struck by lightning and survived.

Five different ways

A person can be struck by lightning in one of five different ways: direct strike, side flash, ground current, conduction, and streamers. Allow me to give a brief explanation of each.

A direct strike is when the victim is struck by lightning directly. Direct strikes tend to occur when the victim is situated in an open area, such as a golf course or sports oval. Although not as common as the other four ways by which a person can be struck by lightning, direct strikes are thought to carry the highest risk of fatality.

A side flash is when lightning strikes a tall object adjacent to the victim, such as a tree under which the victim is standing, and then jumps from that object to the victim. This is why you should never seek shelter from a thunderstorm under a tree or other tall structure. By doing so you actually increase your chance of being struck by lightning, because the tree or other tall structure acts as a lightning rod.

Ground current refers to when lightning strikes close to the victim and then travels along the ground and through the victim's body. It's the most common way by which people are killed or injured by lightning. If the victim is standing or crouching at the time, the current enters the body via the foot closest to the lightning strike, travels through the cardiovascular and/or nervous systems, and then exits via the foot furthest from the strike. The farther apart the victim's feet, the greater the voltage (electric potential difference) between their feet and hence the greater the risk of injury or death. This is why it's recommended you keep your feet as close together as possible when adopting the lightning desperation position. The risk of injury or death is even higher in the case of large four-legged animals with widely spaced front and hind legs, such as cows and sheep.

Conduction is when the victim is struck by lightning by means of being in contact with electrical wiring, metal plumbing, a telephone land line, or some other object or surface that conducts electricity. There are cases where people touching or leaning on metal fences have been killed or injured after lightning either struck the ground nearby or the metal fence itself. The scariest aspect of conduction is that you needn't be outside to be affected by the lightning strike; you could be inside talking on the phone, washing the dishes, having a shower, or using the computer, and still be injured or killed.

Besides putting yourself at risk of being struck by lightning directly by making yourself the tallest object around, it's dangerous to swim in a swimming pool, the ocean, or other body of water during a thunderstorm because water (and salt water especially) conducts electricity.

We now come to the fifth way by which a person can be struck by lightning: streamers. As we discussed in the previous chapter, cloud-to-ground lightning occurs when a stepped leader from the base of a cloud meets a positive streamer reaching up from the ground. Of course, when the stepped leader makes its descent toward ground, multiple positive streamers reach up from the ground to try and connect with it. Usually only one of the positive streamers will make a connection with the stepped leader. However, those streamers that don't make a connection with

the stepped leader also discharge when the main channel discharges. It's possible for a person to be injured or killed by such a streamer discharge.

Lightning's effects on the body

Being struck by lightning is very different from suffering an electric shock. Remember, a stroke of lightning possesses an extraordinarily high voltage (10 to 300 million V), amperage (approximately 30,000 A), and peak temperature (around 50,000 °F) yet is only several milliseconds in duration. Many assume that lightning is direct current (DC) as opposed to alternating current (AC), whereas in fact it could best be described as a unidirectional massive current impulse. It's important to emphasize the word *current*, because scientists classify lightning as a current phenomenon rather than a voltage phenomenon. To be struck by lightning, then, is to be exposed to a quick succession of extremely brief and extraordinarily high bursts of current.

If you've ever received an electric shock from either mains electricity (which is AC) or a powerful battery (which is DC) you'd know how painful they can be. AC electric shocks differ from DC electric shocks. A large DC electric shock will cause a single muscle contraction that throws the victim away from the source; whereas a large AC electric shock will cause sustained contraction of the muscles (called tetanic contraction), preventing the victim from letting go of the source. If the latter is prolonged, massive tissue destruction can occur because of electrical energy being converted into thermal energy (heat). The conversion of electrical energy into thermal energy as current makes its way through bodily tissues is what causes electrical burns. These can be so severe as to necessitate amputation of entire limbs. In short, the injuries of conventional electric shock are primarily thermal in nature. The same does not apply to lightning; it is too short-lived a phenomenon to cause significant heating of tissue.

An Australian boy seated on a horse that has been struck and killed by lightning. Taken sometime between 1890 and 1900. Image courtesy of the State Library of Queensland.

When a human being is struck by lightning, most of the current passes over the surface of the body in a process called "external flash-over." External flashover saves the lives of many

lightning strike victims by diminishing the amount of energy that enters the body. One potential consequence of external flashover is rapid vaporization of moisture on the skin, especially in those areas where sweat tends to accumulate, such as on the chest and beneath the breasts and arms, resulting in burns and blasting apart clothes and shoes. Metal objects on the body such as jewelry can be heated to an extremely high temperature, also causing burns. Fortunately, the millisecond duration of lightning prevents greater heating from occurring. Also, some lightning strike victims come away with reddish fern-like patterns on the skin, called Lichtenberg figures, though these vanish within days.

Only a small portion of the current from a lightning strike passes through the body. Experiments involving sheep have demonstrated that when lightning targets the head area it enters the body through such orifices as the ears, eyes, and mouth. Irrespective of how it has entered the body, the current follows the path of least resistance, which means travelling through nerve tissue, the blood, mucous membranes, and muscle tissue, in preference to higher resistance tissues like tendon, fat, and bone. Drs. Mary Ann Cooper (no relation to Linda Cooper) and Timothy G. Price comment: “Although current may flow internally for an incredibly short time and cause short-circuiting of electrical systems such as the heart, respiratory centers, and autonomic nervous system, as well as spasm of arteries and muscles, it seldom causes significant burns or tissue destruction.”[8]

It is the sudden, violent contraction of muscles caused by current passing through the body that results in some lightning strike victims being thrown many feet through the air. This can lead to bruising and concussion, as can the shockwave that accompanies lightning. Other short-term symptoms include deafness, confusion, dizziness, sore muscles, amnesia, balance problems, and mental clouding. The potential long-term symptoms are numerous, and include problems coding new information and accessing old information, sexual dysfunction, problems multitasking, slower reaction time, distractibility, irritability, personality change, inattentiveness or forgetfulness, headaches, chronic pain from nerve injury, ringing in the ears, dizziness or balance problems, and difficulty sleeping.

According to Dr. Cooper, one of the world’s leading medical authorities on lightning injury (keraunomedicine) and currently Professor Emeritus of the Department of Emergency Medicine at the University of Illinois at Chicago, “Lightning tends to be a nervous system injury and may affect any or all parts of the nervous system: the brain, the autonomic nervous system, and the peripheral nervous system.”[9] The autonomic nervous system (ANS) is especially susceptible to damage from lightning, and many of the symptoms of lightning injury (for example, impotence and hypertension) stem from ANS impairment.

Those who’ve survived a lightning strike generally exhibit few signs of external injury, such as in the way of burns, yet may have suffered a great deal of nervous system damage. Anatomic tests like CT scans, x-rays, and (standard) MRIs often come back normal in the case of lightning strike survivors, because the damage caused by lightning relates to how the brain functions rather than to how it “looks.” It’s fitting to compare the effects of lightning on the body to those of a power surge on a desktop computer. A computer that’s been “fried” by a power surge will look completely fine on the outside, as will the circuit boards inside it. Only if you tried to use the computer would you notice it’s been damaged. For example, you might find that some of its programs no longer run properly, or that some of its files are corrupted.

We know that lightning damages nerve cells in the body, which in turn damages the nervous system. But if this damage isn’t thermal in origin, what causes it? The most likely mechanism

responsible is electroporation, in which electric charges create tiny holes in the membranes of nerve cells. All cells are protected by a semipermeable membrane. The membrane allows certain substances to enter the cell, while keeping other substances out. When a cell is rendered "leaky" by means of electroporation, it is unable to keep nutrients in and wastes out, and so eventually dies. The neurological problems experienced by lightning strike survivors generally take time to manifest, and this appears to be a result of the fact that electroporation causes cells to die slowly.

Using a technique called functional MRI (which differs from standard MRI in that it shows brain activity in real time), it's been revealed that lightning strike survivors exhibit more or less activity than is normal in certain parts of the brain. This is a promising area of research, and may prove to shed much light on the neurological changes that accompany lightning strike injury. Overall, what happens to the body when struck by lightning is something modern medicine knows next to nothing about. To quote Dr. Cooper: "We can't even define what has happened. We can only describe it."[10]

Michael Utley

One of the most widely publicized stories of lightning strike injury is that of Michael Utley, a former stockbroker and today owner of the non-profit organization Struckbylightning.org, whose "purpose is to promote lightning and electrical safety education."[11] On May 8, 2000, while taking part in a charity golf tournament at the Pocasset Golf Club in Cape Cod, Massachusetts, Utley and his three companions noticed a storm in the distance. The storm was not an unusual sight; Massachusetts has its fair share of thunderstorms during the spring and summer months. Paying little attention to the approaching storm, Utley and his companions carried on with the tournament. At the same moment the men happened to be positioned on one of the highest points on the green, they heard the loud blare of the Club's lightning-warning horn. As they rushed off the green to seek shelter, a deafening bang of thunder was heard: Utley had been struck directly by a bolt of lightning.

Utley's companions found him lying on the ground in a "lifeless heap, similar to a broken doll."[12] The lightning had burnt his hair and eyebrows, blown open his zipper, blown off his shoes, and—most worrying of all—stopped his heart. While the group waited for an ambulance to arrive, one of Utley's companions performed CPR on Utley. Had the CPR not been administered, there's no doubt Utley would have sustained acute brain damage due to lack of oxygen. Utley was taken straight to Brigham & Women's Intensive Care Unit, where, for the first few days of his stay, it looked as though his health might improve. He recalls experiencing at the time an "intense thirst"—a symptom common among lightning strike survivors shortly after being struck. During the fifth or sixth day, his health took a turn for the worse, and he began to slip in and out of brief comas. He says he had "turned into a vegetable."[13]

It turned out the lightning had damaged Utley's autonomic nervous system (ANS). As a result, he lost the ability to swallow, so could no longer drink or eat without assistance. Several challenging months of rehabilitation were required before Utley had managed to relearn many of the basic skills and functions that we human beings take for granted, including not only swallowing but shaving, dressing, and "walking down a hall without bumping into walls."[14] Today he's well enough to enjoy such activities as golf, skiing, and bike riding. Yet it's fair to say that Utley, like those who've survived a severe stroke, will never regain the health and vigor he possessed prior to the accident. In a 2002 article he said, "I was 48 going on 35. Now I'm 50 going on 75. I wake up in the morning and I hurt for two hours."[15]

Steve Marshburn Sr.

Steve Marshburn Sr. is the founder and president of Lightning Strike and Electric Shock Survivors International (LSESSI), which is headquartered in Jacksonville, North Carolina. Marshburn was struck by lightning in 1969 in the weeks prior to Thanksgiving during a busy Friday afternoon at work as a teller at the First Citizens Bank and Trust Company on the Main Street of Swansboro. At the time he was in his 20s, recently married with a child, and had been working at the bank for only two years.

On that fateful afternoon, Marshburn was seated on a metal stool at a teller booth adjacent to the Bank's drive-thru window. The bolt of lightning that struck him originated from a storm some 10 to 12 miles east of Swansboro. Its first point of contact was the drive-thru window; it entered the inside of the bank via the drive-thru window speaker, and then shot from the (ungrounded) speaker into Marshburn's spine. (The teller at the drive-thru window had just stepped away for a moment, and, as is the usual procedure, had turned the speaker away from the window.)

Marshburn says that when the lightning struck his spine "it felt as if someone had hit me with a baseball bat."[16] He says the pain was excruciating, and that it felt as though the left side of his head had been split wide open. For a short period he remained in a stunned, semi-conscious state. The following day he felt pain all over his body and had an agonizing headache. He paid a visit to the doctor but the doctor was unable to offer him any assistance beyond referring him to a neurologist. His visit to the neurologist proved equally unfruitful. He returned to work only a few days after the accident, still in a state of poor health.

Over the ensuing months and years, Marshburn's health problems gradually worsened and multiplied to include chest pains, grand mal seizures, bladder and bowel difficulties, body cramps, hearing deficits, a weakened immune system, depression, enochlophobia (fear of crowds), migraine headaches, poor memory, mood problems, and joint stiffness. According to Marshburn, "no doctor on Earth…knew what to do for me."[17] It was some 15 years after the accident, when he was referred to a rheumatologist who diagnosed him with "lightning syndrome," that Marshburn finally began to receive the medical understanding and attention he required.

Marshburn worked a total of 19 years at First Citizens Bank and Trust Company, where he progressed from being a teller to a mortgage specialist. His doctor recommended he retire when it became apparent that Marshburn was struggling with his job due to increasingly severe memory problems and difficulties dealing with numbers. Marshburn attributes both cognitive issues to the fact that when the lightning struck him it "scorched" and "played havoc" with "the left side of my brain."[18] He found his true calling in life when, in 1989, he established LSESSI, "a non-profit support group by and for [lightning strike and electric shock] survivors, their families, and other interested parties."[19] He is quoted as saying: "I am convinced there was a reason I was struck by lightning—to help others."[20]

Jerry LeDoux

Jerry LeDoux, a retired master mechanic in his 70s from Sulphur, Louisiana, has survived two lightning strikes. The first time he was struck was in August of 1999, at the industrial plant where he worked, while standing in an ankle-deep puddle. He recalls being overcome by an intensely bright light—"the prettiest white light you could ever see"—and then waking up half

an hour later, several feet away, with the taste of battery acid in his mouth.[21] The lightning had "thrown" LeDoux a considerable distance—a phenomenon caused by violent muscle contraction. He found himself in a state of numbness and confusion and "couldn't understand anything."[22] When he regained his senses, he noticed his two-way radio, cellphone, and pager had all exploded; he had burn marks on his legs; the glue on the soles of his shoes had come loose; the lining in his hat was burnt; and a stainless steel chain he wore around his neck had "burned…into my chest."[23]

LeDoux returned to work the next day. At the time, he said, "I didn't even know I was hurt. I didn't realize anything was wrong."[24] A doctor he consulted immediately following the accident didn't know anything was wrong with him either, except that his heart had adopted an irregular beat. The damage the lightning caused to his body didn't fully manifest until a month after the accident, when he began to experience short-term memory problems. This impacted his performance at work to such an extent that he had no other choice but to retire. He recalls: "I'd go out to do a job, something I'd done seven days a week, and I couldn't even recognize what the machine was."[25]

It is LeDoux's belief that automobiles offer little protection from lightning, because the second time he was struck was while driving a car in August 2009. Being a tall man (6 foot 1 inch) in a compact space, his body was in contact with the metal parts of the vehicle at the time the lightning struck. After blacking out for a moment, he discovered he was "parked sideways in the road."[26]

Like the majority of those who've survived a lightning strike, LeDoux suffers from an array of debilitating health problems that, for the most part, are a mystery to medical science. His health problems include severe headaches on the left side of his head, pain down his left arm, side, and leg, numbness in his feet, difficulties focusing, chronic irritability, and fatigue. But perhaps his biggest problem is poor short-term memory. "I would've been able to hide my own Easter eggs and not find them," he once joked. "I lose days, sometimes a whole week."[27]

LeDoux's feelings toward lightning are complicated. Although he admits that lightning "scares the daylights out of me," he also feels strangely drawn to it.[28] "[S]ometimes I want to reach out and touch it," he remarked. "My wife doesn't understand that, but I am mentally attracted to it."[29]

Linda Cooper

Linda Cooper, a computer lab supervisor in her 60s from Spartanburg, South Carolina, is famous for having been struck by lightning a total of four times. The first time she was struck was on September 15, 1983, in Ft. Lauderdale, Florida. (She resided in Florida before moving to South Carolina.) When the incident occurred, she had just stepped out of her car and was about to enter the Coral Ridge post office to mail a package. Although overcast there didn't appear to be a thunderstorm in the vicinity. Cooper was the victim of a side flash (also called a side splash), whereby lightning strikes a tall object close to the victim—in Cooper's case the object was a flag pole outside the post office—and then jumps from that object to the victim.

The bolt of lightning struck Cooper in the head and threw her to the ground. She got up and entered the post office with her package, but "couldn't remember what I was doing there, and the others in line kept asking if I was okay."[30] The following day, Cooper was bruised from the fall she'd sustained, while her "arms were tingling and had a great deal of pain."[31] Tiny burn marks

covered her body. She felt extremely fatigued and ended up spending a total of six days in hospital. For an entire year she felt "like I had the flu and a headache that would not go away."[32] The accident left Cooper with permanent cognitive difficulties that include poor short-term memory and the inability to do simple math.

Lightning strike number two occurred on May 27, 1993, in Hillsboro Beach, Florida. Cooper was at home talking on the phone when, even though the sky was clear, lightning travelled down the phone line and "hit the left side of my face."[33] For months afterward, she experienced nausea and what felt like the flu.

When lightning struck Cooper the third time, on July 11, 1994, she and her husband had recently moved from Florida to South Carolina. As in the case of the previous strike, she was inside her home when the incident occurred. This time the lightning reached her not through the phone line but via the plumbing outside and then up through the faucets at the kitchen sink. She had one hand on each faucet when the lightning struck, and she felt it travel up her arms. "It felt," she recalls, "like somebody took a match and lit both my arms. I felt like I was on fire."[34]

During lightning strike number four, on August 22, 2003, Cooper was seated in a car with her friend, Susan Cooper (presumably no relation), in the parking lot of the Hillcrest Mall in Spartanburg. The pair had decided to wait in the car for a storm to pass. Although neither woman was in contact with the metal parts of the vehicle and although the windows of the vehicle were closed, both were harmed by the strike. At the exact moment the lightning hit, Susan was in the middle of handing Cooper a cellphone. The charge travelled through Susan's body; it then made its way through the cellphone, destroying it in the process, and into Cooper's thumb. Whereas Susan sustained minor injuries, Cooper was left with only a small burn on her hand.

The human lightning rod question

That Cooper has been struck by lightning four times is without a doubt incredible. She deserves to be placed, along with Sullivan, in the "human lightning rod" category. Her affinity for lightning extends to the fact that her "car has been struck twice by lightning, her garage door a couple of times, and she has lost telephone service in her house to lightning at least three or four times."[35] Since the "coincidence" explanation falls miserably short, the only logical conclusion to draw is that there is something physiologically unique about multiple lightning strike victims that makes lightning attracted to them; or, as in the manner of a lightning rod, makes them a more preferable target for lightning than surrounding objects.

Presumably this "something" involves electromagnetism, given that lightning itself is a form of EM energy. This explanation is in agreement with Cooper's belief that "the magnetic force of my body pulls lightning toward me."[36] She elaborates: "I may be totally wrong, but you know when you magnetize something it remains magnetized until you demagnetize it. Well, guess what? I'm not demagnetized. Every time I go through an airport security device, I set it off."[37]

You will recall that Sullivan described himself as "just allergic to lightning." On another occasion he said: "Some people are allergic to flowers, but I'm allergic to lightning. I think I must have some chemical or mineral in my body that attracts lightning."[38] Why would Sullivan say he's allergic to lightning the same way certain people are allergic to flower pollen? And how does being "allergic to lightning" have anything to do with attracting lightning? We'll attempt to address these questions later in the book, after we've taken a closer look at EHS.

How does a person become a human lightning rod? Is it a quality they're born with, like left-

handedness, or is it a quality they acquire? The latter explanation seems the more logical. There is a theory among lightning strike survivors that once a person has been struck by lightning they have a far higher chance of getting struck by lightning again. According to LeDoux, whom you'll recall was struck by lightning twice, "There's something about our bodies…. We stand a better chance of getting hit than someone else."[39] Presumably, the property of being a human lightning rod is due to some change in the body brought about by lightning injury.

Oddly, I have yet to come across a case where a human being who was struck by lightning once either died or was seriously injured upon being struck again. It seems to be a rule that when a human being is struck by lightning and survives they acquire a kind of immunity to lightning, so that, if struck again, they not only survive but are only mildly injured.

Carl Mize

Carl Mize is an Oklahoma utility employee in his early 50s who, according to the latest count, has been struck by lightning six times. The first time was in 1978, the year he graduated from high school, while at a rodeo in Claremont, Oklahoma. A muscular, solid man, Mize was there to participate in a bull-riding competition. The rodeo had to be cancelled when a storm appeared overhead. Mize was about to climb into his truck to avoid the rough weather when, at the moment his hand made contact with the truck door handle, "lightning struck and knocked me on my rear end."[40] At first Mize appeared to be more or less unhurt. Later, at work, he developed a high fever and ended up in hospital. He was forced to take a month off work to recover his health.

Lightning strike number two occurred in 1985 or 1986; strike number three on August 9, 1996; number four on May 3, 1999; number five on August 5, 2005; and the most recent—lightning strike number six—in August 2006. Additionally, Mize lost his house some two decades ago due to fire caused by an electric short, and has been electrocuted by mains electricity on a number of occasions. On one of those occasions, Mize was in a duck pond fixing a fountain. Although the electrician had assured him that the electricity to the pond lights was turned off, Mize cut a wire under water and was instantly electrocuted. The jolt he received was "enough to kill someone," yet, strangely, as with the other electric shocks he's endured, "I was never hurt."[41]

It would appear that Mize is not only immune to lightning but to electricity in general. Such immunity is baffling and warrants scientific investigation. Just as baffling is the fact he's been struck by lightning six times. To the best of my knowledge, no other person alive today has been struck as many times as Mize. And, given that he's only in his early 50s, it wouldn't be surprising if he ends up matching, or even surpassing, Sullivan's record of seven lightning strikes. On one occasion he remarked, "My boss who runs the power plant at Oklahoma University believes there's something in my body that attracts lightning."[42] He added, "[I] believe it [lightning] does like me for some reason."[43]

"Lightning Kin Cursed"

If lightning is attracted to certain people, could it also be attracted to certain families? Although I admit this question sounds preposterous, it's worth reflecting on in the case I'm about to describe.

On July 3, 2011, Stephen Rooney, 54, of Hammonton, New Jersey, was in his backyard smoking a cigar during a weekend picnic with his extended family when a bolt of lightning struck the tree under which he was standing. The storm had rolled in just moments before, at which point the majority of Rooney's guest had gone inside to attain shelter. Rooney and four of his male guests chose to remain outside in order to smoke cigars. The lightning strike to the tree resulted in a side flash that injured both Rooney and his cousin Scott Digerolamo. Digerolamo, who happened to be standing further from the tree than Rooney, ended up in hospital with only minor injuries. Rooney failed to regain consciousness and died five days later in hospital.

Moments before the strike, Rooney told his guests that they needn't be worried about the storm because "lightning never strikes the same family twice."[44] The comment related to his father, George Rooney, who was struck and killed by lightning while fishing in a boat near Fortescue, New Jersey, when Rooney was 5 years old. The story of Rooney's death by lightning strike and the strange coincidence surrounding the affair was covered by such popular newspapers as the *New York Post*, under titles that include "Lightning Kin Cursed" and "Father and Son Both Victims of Lightning, 48 Years Apart."

The fact that Rooney and his father were both struck by lightning, many decades apart from each other, is extremely astonishing. Adding to the astonishing nature of the case is that both died as a result of those strikes, rather than lived. After all, it's far more common to be struck by lightning and survive than it is to be struck by lightning and die. When death does occur, in most cases it's due to cardiac arrest. You will recall that Michael Utley suffered cardiac arrest from being struck by lightning, yet was kept alive by CPR until paramedics arrived. Rooney, unfortunately, was not so lucky.

Positive stories

In view of the lightning strike cases we've looked at so far, it's difficult to see anything positive about being struck by lightning. Generally, those unfortunate enough to be struck either die more or less instantly or, more likely, survive yet sustain much damage to their bodies. Most lightning strike survivors battle with depression, and some, as we've seen, commit suicide. Partly as a result of the changes in personality experienced by many lightning strike survivors, which can involve becoming grouchy, short-tempered, and irritable, it's not uncommon for marriages to break down and for survivors to end up living in isolation. Yet it's not all doom and gloom. Cases exist where people have been healed of medical conditions after being struck by lightning. Then there are cases where survivors have developed alleged psychic abilities. Some survivors insist they are better for the experience and even grateful they were struck.

Harold Deal

One survivor who views his ordeal in a remarkably positive light is Harold Deal, a former maintenance electrician in his 70s from Greenwood, Missouri. After being struck by lightning on July 26, 1969, while standing in the driveway of his home (in Lawson, Missouri), Deal developed severe memory problems, whereby occasionally he could no longer recall how to talk, walk, and perform other simple tasks. Strangely, he also lost his sense of smell and the ability to experience pain and cold. Because he doesn't "notice the cold like most people," some of his fellow townsfolk call him "Weird Harold."[45] He explains: "They call me this because I never wear a coat or long-sleeve shirt no matter what the weather is outside…I have worked outside in

26 degrees below zero, plus I have worked in weather with a wind chill as low as 56 degrees below zero…I have also worked in 23 degrees below zero for up to seven hours at a time. A T-shirt and overalls is what I always wear…whether it is summer or winter."[46] Today a dedicated Christian and charity worker, Deal feels that, looking back on the accident, it made his life "so much richer and so much fuller."[47]

Betty Galvano

Betty Galvano of Sebring, Florida, a former high-fashion model and widow of the late celebrity golfer Phil Galvano, is a remarkable example of someone who's been healed by lightning. In 1993, Galvano fell off a seawall and broke her right leg. The accident necessitated an operation in which two 14-inch steel bars were permanently inserted in her leg. Although the operation enabled Galvano to walk again, it left her in pain and unable to use her leg to the extent she could before the accident. She explains: "[I] couldn't jump or raise my leg. I couldn't stand on one leg. I couldn't walk without dipping. My leg always felt like a sandbag."[48]

On the afternoon of June 11, 1994, while cutting up broccoli in her son's kitchen with the window open, Galvano heard "the most unbelievable tremendous blast of thunder."[49] The next thing she knew, she was slumped over the counter, the knife and broccoli having flown from her hands. The bolt of lightning that struck Galvano had entered via the open window. Her husband, who'd been sitting 4 feet away from her when the incident occurred, helped her to the couch so she could lay down.

While lying on the couch, Galvano experienced a strange sensation in her crippled right leg, as though "a thousand needles had entered the toes and foot."[50] All of a sudden her leg felt "full of vitality."[51] She recalls: "I stood up and everything was fine. I could walk normally."[52] The pain had also vanished. Galvano claims that not only did the lightning strike "miraculously heal" her leg, but that she didn't suffer any ill effects from it, not even the slightest amount of memory loss. The day after the incident she paid a visit to her doctor, who confirmed that her leg had indeed been healed.

Although the effects of being struck by lightning vary from one individual to another, no one is ever the same as before they were struck. Some survivors undergo a kind of "spiritual awakening," or at the very least acquire a deeper interest in spiritual matters. Something of this nature happened to Galvano. At the moment she was struck by lightning she saw "gold particles everywhere" and experienced "a beautiful, peaceful feeling that God loves us [and] that the only thing that's worth anything is love."[53] She adds: "Lightning was a spiritual experience for me. It energized me, it made me feel better."[54] It also left her feeling "totally immersed in God," so that now "He is with me all the time."[55]

According to Galvano, her unique relationship with lightning dates back to when she was a newborn in Atlanta, Georgia, in 1935. She claims that a tremendous thunderstorm occurred on the day her mother brought her home from the hospital. The storm caused an electrical cable outside the house to break, which then produced an electrical shortage inside the house and much electrical arcing. Later, when she was three months old, she developed blue baby syndrome and fell into a coma. There was a high chance she might die. As the infant Galvano lay ill in hospital, a raging thunderstorm took place outside. Galvano picks up the story: "My mother looked out the window, and on the lawn she saw a ball of lightning. It floated up, came through the window, and rested on top of me. At that moment a nurse came into the room and watched with her mouth

wide open as I came out of the coma."[56]

As tempting as it is to dismiss Galvano's ball lightning story as the product of an overactive imagination, it's not unheard of for ball lightning to approach an individual and brush against their body without causing any harm. So it's conceivable she had a ball lightning encounter as an infant where the object "rested on top of me." Whether the object healed her, though, is another matter entirely.

Robert Davidson

The case I'm about to describe is hardly an example of someone being healed by lightning, though it involved a healing of sorts. In June 1980, Robert Davidson, then aged 38, was riding his motorbike down Interstate 74 on his way to Indianapolis when suddenly it started to rain. Seated behind him on the motorbike was his wife. The two decided to pull off the road to put on their wet weather gear. Davidson's wife dismounted the motorbike first. Just as Davidson was dismounting, with his left foot on the ground and his right leg still on the seat, he was struck on the shoulder by a bolt of lightning. Davidson was sent flying through the air and landed on the ground without a pulse. A physician who happened to be driving by pulled over to assist Davidson, giving him CPR and calling an ambulance.

Both the physician and the team of ambulance paramedics desperately tried to restore Davidson's heartbeat, but with no luck. As their attempts continued without success, it began to look inevitable that Davidson wouldn't make it. What happened next sounds like something out of a Stephen King novel. A woman carrying a Bible and wearing an old-fashioned–style black dress suddenly arrived at the scene. "Let me touch him," she yelled out, as she made her way toward Davidson.[57] Given the hopeless nature of Davison's condition, the paramedics decided they had nothing to lose by letting the woman approach him. "She knelt down beside me," Davidson said, "and placed the Bible and one hand on my chest and the other hand on the ground. She proceeded to lift the Bible to the sky and muttered something that no one understood."[58] The woman—who came to be known as the "woman in black"—then got up and walked away, and was never seen again. Moments later Davidson had a pulse.

The identity of the woman in black remains a mystery to this day. She appeared in an instant and vanished in an instant. Although some of the witnesses and paramedics at the scene say they didn't see the woman, others are adamant they saw her and that she indeed saved Davidson's life. Paramedic Marylou Shafer belongs in the latter group. "There is no doubt in my mind," she commented. "She was there."[59] Davidson was taken immediately to the hospital, where he remained in a comatose state for seven weeks, then spent several additional weeks relearning how to walk. The lightning strike damaged his vocal cords, and it was two years before he was able to talk again and nine years before he was well enough to return to his job at General Motors.

Peculiar Aftereffects

Davidson claims that for many years following the accident he was unable to wear a wristwatch without it malfunctioning within a matter of days. The only watch he could wear that didn't malfunction (and in fact continued to keep perfect time) was the one he had on his wrist at the time of the accident. Actually, many lightning strike and electric shock survivors claim they exert an odd effect on wristwatches. Furthermore, the claims don't apply exclusively to

wristwatches but involve all manner of electrical gadgets—from computers to automatic garage doors to streetlamps.

In June 1989, former storm chaser Steve Melvin of Ohio, now in his early 50s, happened to get struck by lightning at the precise moment he was taking a photo. The camera was partly melted by the lightning, yet the film inside was undamaged. Remarkably, the photo he took at the moment he was struck shows the ghostly outline of a human surrounded by lightning, even though neither he nor anyone else was situated in front of the lens at the time. Melvin commented: "Some say it was me having an out-of-body experience. Some say it was my grandmother coming down from heaven to push me out of the way of the lightning. Some say it was a glimpse of an entirely different dimension. I'll never know."[60] Ever since the incident, Melvin has had to replace on a frequent basis the batteries inside the pager he carries on his person; they go flat within days yet are supposed to last for months.

Could there be a mundane reason why the batteries in Melvin's pager appear to mysteriously go flat? Perhaps the device is damaged in such a way that it uses more power than it should. Or perhaps, due to brain damage sustained during the accident, Melvin has difficulty remembering when he last put batteries in the device. The only reliable way to get to the bottom of the matter would be to carry out a series of experiments involving Melvin and his pager. This aside, the fact that many lightning strike and electric shock survivors make claims similar to Melvin's means we're faced with a genuine mystery.

In a 2009 *USA Today* article titled "Florida Lightning Survivors Share Stories," one of the stories featured is that of Ralph Weidner of Bonita Springs. Since being struck by lightning in 1968 during a camping trip in Colorado, Weidner has had "difficulty using electronic devices."[61] He elaborates: "Battery-operated watches last only a few months and cellphones are a problem as well. I have had my cellphone keypad fail to work, but when I hand it to someone else, it works just fine. This has happened several times."[62]

In *Out of the Blue*, Friedman presents a number of cases where "lightning survivors have claimed electrical or magnetic powers…."[63] One of the cases presented is that of Gabrielle Blanstein. After being struck by a bolt of lightning that entered through the open window of her home in Haydenville, Massachusetts, in 1996, Blanstein became "supersensitive to electrical current."[64] She can tell when an electrical device is plugged in nearby because she can feel in the form of vibrations the EM field surrounding the device. Blanstein claims to have accidentally demagnetized two bank cards and a credit card. Could it be that Blanstein suffers from EHS? Her ability to sense EM fields certainly suggests as much.

Another case presented by Friedman is that of Nina Lazzeroni, a dental assistant and part-time motorcycle safety instructor in her late 50's from Dover, Delaware. On the afternoon of April 8, 1995, Lazzeroni was struck by lightning while standing in a parking lot in Troy, Ohio, in front of a number of students to whom she was delivering a lesson on motorcycle safety. Her students witnessed the entire event. She said, "They told me I flew up like a rag doll and landed on my head."[65] Lazzeroni spent a week in hospital. The accident left her with a shattered left eardrum (which later healed but developed into tinnitus), an abnormal heart rhythm, permanent numbness in parts of both feet, memory issues, personality alterations, and difficulty reading and talking. Lazzeroni surmises that the lightning entered her brain and fried her pituitary gland and other parts of her endocrine system, because after the accident she began to experience "such drenching menstrual periods that I was forced to have a hysterectomy."[66]

Fortunately, Lazzeroni has made a dramatic recovery and now finds it much easier to read

and talk. Of those symptoms that remain from the accident, one is extremely peculiar: Lights of all kinds, particularly ones in public places like streetlamps and billboard lights, have a tendency to switch off in her presence, though at unpredictable moments. She explains: "They come back on after I leave the area and turn off again if I return. It's not uncommon to have three or four go out while I'm driving somewhere at night. I feel no electricity or any other sensation—I just find myself in the dark periodically."[67] The phenomenon described by Lazzeroni falls into the category of streetlamp interference (SLI), which we will discuss further in the next chapter.

Kurt Oppelt, who with Sissy Schwarz won a gold medal at the 1956 Winter Olympics in the pairs figure skating event, was struck by lightning in 1989 while standing in his bathroom. Doctors he consulted the following day could find nothing wrong with him. And yet, explains Oppelt, "audio receivers, cash registers, and computers broke when I touched them…. A friend of mine gave me a laptop, but I can't use it. I told my cardiologist that my 'electrical system' was disturbed, but the doctors say they have no scientific proof. I told another doctor what happens when I touch electrical gadgets, and he said, 'So don't touch them.'"[68]

Psychic abilities among lightning strike survivors

The alleged development of psychic abilities is not an uncommon feature among cases where people have survived a lightning strike. While looking through the many lightning strike "survivor stories" posted on the National Oceanic and Atmospheric Administration (NOAA) website, I came across two claims of psychic ability. The first claim concerns a woman named Missy. Missy was struck by lightning through a landline telephone while ordering pizza during a thunderstorm. At the moment the strike occurred, she heard a "loud explosion" and noticed at her feet "a bright white light…which was football shaped and had spikes."[69] (This is a perfect description of ball lightning, which can indeed emerge from telephone handsets and also assume a "spikey" appearance.)

The explosion knocked Missy backward, and for a moment she remained on the floor in an unconscious state. She then experienced a strange "numbing feeling" work its way up one side of her body. Missy was taken to the hospital emergency room, where doctors confirmed she'd been struck by lightning. After the accident, according to Missy, she developed as a "side effect" (her term) extrasensory perception (ESP). She explains: "There have been times where I speak someone's name, someone that I haven't heard from or seen in many years and all of a sudden they walk in the door…I've had eerie feelings about things just before they actually happen. Most people that know me are amazed. And so am I. This periodic thing only started after my lightning incident."[70]

The second claim of psychic ability on the NOAA website concerns a nurse in Nashville, Tennessee, named Thais. Thais was struck by lightning on two separate occasions. The first time, in May 1985, she had been standing next to an open window drawing blood from a patient seated on a chair when lightning entered the building through the window and struck both her and the patient. The event was witnessed by the patient's wife, who described the bolt of lightning as orange in color and added that it appeared to go around as well as pass through the bodies of both Thais and the patient.

Thais's encounter with lightning left her with few, if any, injuries. A couple of months after the incident, however, she noticed two strange aftereffects. First, she could no longer wear a watch without it "losing 10 to 20 minutes and becoming unreliable."[71] She adds: "At first I kept

thinking I was buying watches that were too inexpensive. It took a couple [of] years to realize it wasn't the watches but me that was the problem!"[72] The second strange aftereffect is that her psychic abilities became heightened. She comments: "This [heightened psychic abilities] is not something I previously had interest in and definitely not something I was looking for. I have always been a very private person and didn't want to know things about other people, but I found myself somehow knowing things about folks I didn't know well."[73]

The second time Thais was struck by lightning was while talking on the telephone during a Thanksgiving weekend some six to eight years after the first strike. Since then, she says, the well pump at her home has been struck by lightning twice.

Greta Alexander

Greta Alexander (1932–1998) of Delevan, Illinois, was a famous psychic whose expertise included palmistry, numerology, "medical intuition," and assisting police with missing persons cases. Born on a farm in Manito, Illinois, she spent the first part of her adult life as a regular mother and housewife. One night in April 1961, while pregnant with her fifth child, she was lying in bed watching a thunderstorm out the window when "a white light came at me through the window, and the next thing I knew the Venetian blinds were wrapped around me and there was a fire burning a hole in the bed."[74] Although the bolt of lightning damaged her bedroom window, knocked down the chimney, and set fire to her bed, it didn't harm her or her unborn child in any apparent way.

Shortly afterward, she suffered an electric shock while plugging a second-hand refrigerator into a faulty electrical outlet. It was soon after the lightning strike and subsequent electric shock that Alexander's psychic abilities were "awakened." She found herself answering the telephone moments before it rang, and noticed she was able to "read" the minds of others. She eventually established herself as a professional psychic, being paid by clients to perform palm readings and the like.

Her work assisting police with missing persons cases (for which she received no payment) began in 1974. Perhaps the best known case in which her psychic talents proved useful was the 1983 murder of Mary Cousett by her boyfriend Stanley Edward Holliday Jr. At the time Alexander was asked to assist in the case, Holliday had already been charged with Cousett's murder, yet the whereabouts of Cousett's body remained unknown. Thanks in part to Alexander's help, the police located Cousett's body on October 29, 1983. "She told us a lot of things that turned out to be true—20-some points that fit," commented Lt. Donald Sandidge, "like that the head and foot would be separated from the [victim's] body, [and] that a man with a crippled hand would find her."[75] (The man who found her body, an auxiliary officer by the name of Stephen M. Trew, had a deformed left hand due to an injury he'd sustained in the past.)

That Alexander was highly psychic is difficult to refute. However, the reason she deserves mention here is not to illustrate the fact that psychic abilities are genuine and can be used to help solve crimes, but that both lightning strike and electric shock play an important role in the "awakening" or attainment of psychic abilities. Given that Alexander was struck by lightning then soon after sustained an electric shock, there's no way to know which of the two incidents was responsible for her "psychic awakening."

Lightning shamans

Had Alexander lived in a society where shamanism is practiced, it's likely she would have been considered a shaman as opposed to a mere psychic. According to German ethnologist and psychologist Holger Kalweit, in shamanic traditions the world over, being struck by lightning is one of the ways by which people are initiated into shamanism. "The Greeks believed a person struck by lightning was in possession of magical powers," he explains, "and in tribal cultures throughout the world lightning shamans are often venerated and feared as the mightiest of shamans."[76]

To be initiated into shamanism is to take up the shamanic path. Apparently, this happens not by personal choice but under the will of a higher power. During shamanic initiation, the initiate symbolically dies (undergoes dismemberment) and is reborn (put back together). They acquire as a result of this challenging and traumatic process mediumistic and other psychic abilities.

There is a belief among the North American Indian tribes known collectively as the Sioux that when a person is struck by lightning or has visions featuring Wakinyah ("thunderbirds" or "thunder beings") it can indicate they've been chosen to become a special type of medicine man called a Heyoka ("thunder dreamer"). A Heyoka differs from a conventional medicine man in that he does everything in a contrary fashion. He is a sacred fool, whose clownish antics are a source of amusement to others. The powers with which Heyokas are gifted derive from the thunderbirds. A thunderbird is a spirit of lightning and thunder in the form of a huge Eagle-like bird. They produce lightning from their beaks; they produce thunder through the beating of their wings. They are also responsible for the production of rain.

The famous Sioux Indian warrior and holy man Black Elk (1863–1950) followed the path of Heyoka. At the age of nine he was taken deathly ill and confined to bed for approximately 12 days. During this period of illness, he experienced a great vision in which he was visited by the thunder beings and taken to see the "grandfathers." The grandfathers taught him important lessons that contributed to his eventually becoming a shaman. "Only those who have had visions of the thunder beings of the west can act as heyokas," he explains. "They have sacred power, and they share some of this with all the people, but they do it through funny actions."[77] These "funny actions" can include running around naked in the middle of winter and shivering and complaining of the "cold" in the middle of summer; answering "yes" when one actually means "no"; and wearing one's clothing and boots back-to-front. (One is reminded of Harold Deal's inability to feel the cold.)

Since, in spiritual terms, lightning is sacred and powerful because it originates from heaven, to be struck by lightning and survive is to be rendered powerful and sacred. To be struck by lightning and die, on the other hand, is to be punished for having done something to challenge fate. Did Stephen Rooney "challenged fate" when, shortly before he was struck by lightning, he joked to his guests that "lightning never strikes the same family twice"? Would he never have been struck by lightning had he not issued this remark? Rhetorical though these questions are, I think it's fair to say there is an intelligent component to lightning. It almost seems to have a mind of its own.

An interview with Dr. Mary Ann Cooper and Dr. Christopher J. Andrews

In Chapter 3 we established that the most common way people develop EHS is through being exposed to a powerful source of EM radiation. For example, Veronica Ciandre developed EHS after a cluster of cellphone antennas were installed on the roof of her apartment building. Since lightning strike and severe electric shock qualify as forms of heavy exposure to

electromagnetism, EHS ought to be fairly common among lightning strike and electric shock survivors. And indeed, we've already come across a couple of lightning strike survivors whose symptoms match those of EHS.

If lightning strike and severe electric shock can lead to the development of EHS, we would expect allergies and intolerances of all kinds to be common among lightning strike and electric shock sufferers. Suggesting as much is the following excerpt from a detailed paper on lightning injuries: "Although there have been anecdotal reports of increased hypersensitivity, development of allergies, and increased risk of cancer in lightning victims, perhaps indicating an immunological component to lightning injury, these have not been studied."[78]

Partly in order to better understand the connection between lightning strike and electric shock and EHS, I got in touch via email with two world leading authorities on keraunomedicine, Dr. Mary Ann Cooper and Dr. Christopher J. Andrews. I introduced Dr. Cooper earlier in the text. Dr. Andrews is a family practitioner, and works as an aviation medical examiner at Mt. Ommaney Family Practice, in Brisbane, Australia. He was originally an electrical engineer and continues clinical and research interests in electrical and lightning injuries. Both Dr. Cooper and Dr. Andrews courteously agreed to answer a short list of questions concerning the more controversial aspects of lightning strike and electric shock injury.

I asked if it's common for lightning strike and electric shock survivors to claim as one of their health problems either MCS or EHS. "I do not have any evidence, properly tested and controlled, that either of these [EHS or MCS] exist," answered Dr. Andrews. "I have a couple of people who claim electromagnetic sensitivity. Superficially their claims are interesting and hard to refute, but I have no trials of this…."[79] He commented on one of the cases of alleged EHS: "One lady stated she was able to tell when she was in proximity to electronic apparatus. Blinding her in an ad hoc test in my rooms did indicate that she correctly predicted proximity to a computer, but this was only one ad hoc case, quite uncontrolled for scientific veracity."[80]

Dr. Cooper also acknowledged that claims of EHS and MCS occur among lightning strike and electric shock survivors. "I do not dispute their claims," she added, "but there is no scientific basis for a physical cause nor validation of their complaints or abilities to detect EMF… I listen to them but the complaints are very nonspecific."[81]

In response to my question as to whether it's true that many lightning strike and electric shock survivors claim to be able to disrupt electrical devices in an unusual manner, Dr. Cooper answered in the affirmative. Yet she is extremely skeptical of such claims and pointed out that they haven't been "substantiated scientifically."[82] She added: "I have even had people tell me they cannot wear a watch on their wrist but can wear it from a leather belt loop—now you tell me what the difference is there!… Think about whether an inanimate object (a tree or building, for instance) that has been hit by lightning could disrupt future electrical equipment that it comes in contact with—that has not been shown either."[83]

To me it seems unusual that Dr. Cooper would compare the human body to a tree or building and then use that comparison as evidence against the notion that human beings are able to disrupt electrical devices in an unusual manner. When I asked her to detail some of the claims made by lightning strike and electric shock survivors regarding the disruption of electrical equipment, she responded: "Batteries go dead too soon; battery watches stop working; garage door openers won't work; computer screens go blank; [and] computers 'crash.'"[84] What did Dr. Andrews say on the matter? "I do not have any of my patients claiming that they disrupt electrical devices," he commented, "except for a couple who say streetlights go out as they walk past. This did not

happen to lights in my room."[85] He, too, was quite skeptical about any scientifically proven mechanism for this interaction.

My next two questions concerned the topic of "human lightning rods." As I stated earlier, there is a theory that when a person has been struck by lightning once they have a far higher chance of being struck by lightning again. Aware that Sullivan was allegedly first struck by lightning as a child, I asked Dr. Cooper and Dr. Andrews if they had met or treated any lightning strike/electric shock survivors who, like Sullivan, claimed to have first been struck by lightning/electrocuted as a child. "I have treated a tiny number struck as a child, but not necessarily subsequent," Dr. Andrews responded. "I do not consider that being struck once gives any increase in risk of being struck again…. The probability of a strike is purely geometrical, and if one inhabits a geometrical location of increased risk then the likelihood of being struck is higher."[86] Dr. Cooper answered "Yes" to this question but unfortunately provided no information beyond that.

I asked whether it's conceivable to suggest that certain people get struck by lightning multiple times because their bodies generate an unusually strong EM field. After all, I added, it's been proven that the human body generates a weak EM field. Dr. Andrews's response was a definite "No." He elaborated: "Indeed there are a group of 'modern' lightning rods which claim to be more effective because they act in this way [generate a strong EM field]. Their claims have been scientifically dismissed."[87]

Dr. Cooper's response tallies with Dr. Andrews's. After explaining that devices with definable EM fields, such as cellphones, IPods, and so forth, neither attract lightning nor are more likely to be hit by lightning than objects that do not emit EM fields, she stated: "If electronic devices do not 'attract' lightning or are not 'more likely' to be hit, why would anyone think that a person/body (with immeasurably weaker EMF individually—or as a result of 'differences' in EMF between individuals) would be more prone to being hit by lightning?"[88]

The last question I asked Dr. Andrews and Dr. Cooper is whether they had met or treated any lightning strike or electric shock survivors who claimed that their bodies have an unusual tendency to accumulate static electricity. The reason I asked this question is simple: I had discovered during the course of my research that many lightning strike and electric shock survivors, as well as many sufferers of EHS, complain that their bodies have an unusual tendency to accumulate static electricity, resulting in frequent shocks. You will recall that Veronica Ciandre said she experienced static shocks on a frequent basis during the early stages of her acquiring EHS.

Dr. Andrews answered "No" to this question and said he doubts the phenomenon exists. Dr. Cooper answered "Yes" to this question and mentioned she'd met "several" such people. She added: "I receive comments (generally by email, which I have been receiving from all over the world for nearly 20 years) from individuals every few years who complain of this type of sequelae. Occasionally when I am giving a lecture, someone will approach me afterward with such a complaint. None of the claims by any of these people have been validated scientifically and I have never witnessed any demonstration that these complaints are what the people (albeit totally sincere) report."[89]

It was kind of Dr. Andrews and Dr. Cooper to answer my questions. However, with all due respect to their expertise and profession, I cannot help but find some of their views a touch narrow-minded. On the whole, both expressed considerable skepticism toward many of the more unusual aspects of lightning strike and electric shock injury. Dr. Andrews was the less skeptical

of the two, as evidenced by the fact that he went to the trouble of testing one of his patients for EHS; Dr. Cooper came across as extremely unwilling to open her mind to the possibility that EHS and similar phenomena exist. Her overriding attitude seems to be that all unusual claims made by lightning strike and electric shock survivors are a product of delusion caused by brain injury.

Wimshurst disorder

The phenomenon whereby the body persistently accumulates a high static charge, resulting in frequent shocks, will from now on be referred to as "Wimshurst disorder," in reference to the Wimshurst machine, a type of electrostatic generator that consists of two parallel insulating discs that revolve in opposite directions. (The machine is named after its inventor, the British engineer James Wimshurst [1832–1903].) Giving a name to the phenomenon means greater economy of language. I've chosen to refer to it as a "disorder" because it has all the trademarks of one. The term *disorder*, which is defined as "an abnormal physical or mental condition," is synonymous with "ailment." An ailment is a mild illness. And, indeed, Wimshurst disorder is very much associated with illness.

At least one study has helped shed some light on the connection between Wimshurst disorder, EHS, and electric shock. Published in 2007 in the journal *Bioelectromagnetics*, the study was in part an attempt to identify the key symptoms of EHS. In one component of the study (Study 1), an EHS questionnaire survey was sent to a randomly selected sample of 20,000 people who lived within a 20 mile radius of Colchester, United Kingdom. Of the 3,633 people who responded to the survey, 698 of them (19.2 percent) reported being sensitive to EM fields. Those who responded otherwise served as the control group in a second component of the study (Study 2).

In Study 2, 88 individuals who'd been identified as suffering from EHS completed the survey from Study 1. Significantly, 42.0 percent of those in the EHS group compared to 32.9 percent in the control group reported that they had at one time experienced a severe electric shock. It was also discovered that the EHS respondents experienced static shocks significantly more often than the control respondents. "One possible explanation is that perhaps EHS individuals are more self-aware than control individuals and this awareness leads to a greater reporting of static shocks," suggested the authors of the study.[90] This explanation would no doubt appeal to the likes of Dr. Cooper and other conservative thinkers. I, however, find it woefully inadequate.

■■■

It's important to acknowledge that Wimshurst disorder rarely occurs on its own; in most cases it occurs as one of several symptoms or effects exhibited by those who have high voltage syndrome (HVS), otherwise known as "electric people." In the next chapter we'll examine in detail a number of cases of HVS as well as investigate the connection between HVS and EHS.

6 Electric People and Poltergeist Agents

Published in the June 1920 issue of the *Electrical Experimenter* journal is an article titled "Poisoned Convicts Become 'Electrified!'" The article describes an outbreak of botulism poisoning, caused by consuming contaminated canned salmon, among 34 convicts at Clinton Prison, Dannemora, New York, on February 20, 1920. That this was no ordinary outbreak of botulism is revealed by the fact that all 34 of the ill convicts developed Wimshurst disorder. The matter came to the attention of, and was studied in detail by, the chief physician at Clinton Prison, Dr. Julius B. Ransom. "[I]t was discovered by accident that peculiar static electric power had developed in the patients," Dr. Ransom stated.[1]

According to Dr. Ransom, that the patients had developed "peculiar static electric power" became apparent when one of the patients crumpled up a piece of paper and attempted to throw it into the wastebasket, only to find that the paper "absolutely refused to leave his hand."[2] From that point on, Dr. Ransom and his staff involved the patients in a series of experiments.

In one type of experiment, a patient would rub his hands together and then touch a sheet of paper, causing the paper to become highly charged. Dr. Ransom claims that the charged piece of paper, when placed on a wall (or other surface), would remain clinging to the wall "for many hours."[3] Also, if the charged piece of paper was brought close to a surveyor's compass, the needle of the compass would rotate. (Presumably the same effect was achieved by having the patient place his hands in close proximity to the compass.)

Another type of experiment was performed whereby a patient would rub his hands together and then rub the outside of an incandescent bulb. By then placing one of their hands a short distance away from the globe, the metal filament inside, being attracted to their hand, would lean against the inside of the globe and also follow the movement of their hand. Dr. Ransom notes that the experiment resulted in "a good deal of sparking at the base of the filament."[4] A similar type of experiment was performed using a steel tape measure suspended from the ceiling, the patient causing the apparatus to swing back and forth.

Given that botulism results in dry skin, coupled with the fact that static electricity favors dry conditions, it's logical to suggest that the patients' bodies became highly charged with static electricity due to these factors alone. Yet Dr. Ransom notes that the patients were able to perform the same amazing feats when in a tub of water as when completely dry and fully clothed. Had this been a mundane case of static build up on the body, being placed in water would have rendered the patients static free. That it didn't render them static free indicates that the electricity was being generated internally—a point we'll revisit in a moment.

Dr. Ransom further notes that as the patients recovered from the poisoning they slowly lost their electrified properties. He explains: "The ability to electrify is proportioned to the severity of the disease: as the patient convalesces he gradually loses this power and when quite well loses it altogether."[5]

What is botulism?

Botulism is a rare but potentially fatal illness that affects the autonomic nervous system (ANS). It is most often caused by eating improperly sterilized canned foods containing the botulinum toxin. The botulinum toxin, which is produced by the soil-dwelling *Clostridium botulinum* bacteria, is one of the most potent poisons known. When the toxin is ingested through food, it makes its way via the bloodstream to nerve endings in muscles, where it blocks the release of acetylcholine, the neurotransmitter responsible for triggering muscle contraction. An absence of acetylcholine means the muscles cannot contract and so they become paralyzed. (The toxin's ability to cause muscle paralysis has been exploited for cosmetic purposes; Botox treatments consist of injecting small amounts of the toxin into the facial muscles, causing the muscles to relax and wrinkles to disappear.) In fact, the main reason botulism can be fatal is because it causes paralysis of the respiratory muscles, which in turn can lead to asphyxiation. Other symptoms of botulism include drymouth, headache, dizziness, blurred or double vision, nausea, vomiting, and abdominal cramps.

The fact that botulism disrupts electrochemical processes within the body is perhaps key to understanding the connection between it and Wimshurst disorder. The question naturally arises as to whether Wimshurst disorder is an actual (albeit very rare) symptom of botulism, or if additional factors were responsible for causing the patients at Clinton Prison to become highly charged with static electricity. Is this the only case of its kind in the entire history of medicine, or has it happened to others?

■■■

Also, it is important to note that, whereas the patients at Clinton Prison experienced Wimshurst disorder only for the period during which they were ill with botulism, for others Wimshurst disorder is a long term, even permanent, affliction. Furthermore, it tends to be accompanied by other electrical effects. As I explained in the previous chapter, those who experience Wimshurst disorder in addition to other electrical effects are referred to as electric people, or high voltage syndrome (HVS) sufferers.

Mavis Price: the "super-charged grandmother"

A compelling case of HVS was reported in the *Daily Mail* newspaper in 2008, under the comical title "Meet Mavis, the super-charged grandmother whose touch BLOWS UP kettles." The "super-charged grandmother" in question is Mavis Price, a retired community development worker in her mid-60s, from Telford, Shropshire, United Kingdom.

According to Price, her body "seems to build up an unusual amount of static [electricity]."[6] Because of this, she says, electrical appliances and gadgets of all kinds, including kettles, irons, printers, vacuum cleaners, and computers, have a tendency to malfunction when she touches or stands near them. If fact, so destructive is her influence on electrical devices that she's continually replacing the ones in her home. Price claims that it's not uncommon for televisions to "crackle" as she walks past them, and that sometimes people who touch her—or merely stand near her—either receive a powerful static shock or experience their hair standing on end.

Like many afflicted with HVS, Price goes through periods during which her destructive influence on electrical equipment is particularly acute. She explained: "I had a really bad day last week where I got up, turned the light on, and managed to blow the fuse. Then I went to the supermarket and broke the checkout. They had to close the checkout down and said nothing like

it had ever happened before. Just when I thought things couldn't get any worse I went to get some photographs printed and managed to completely freeze the whole machine."[7]

Understandably, Price's condition has made her life a challenge in some respects. For example, at one time she set out to complete an IT training course, yet "every time [I] touched the computer it would either freeze or shut down. The technician had to constantly come over to my machine to see what was wrong and he was completely baffled."[8] The course became such a "nightmare" that she ended up not completing it.

Significantly, Price traces the beginning of her strange relationship with electrical equipment to a childhood incident whereby she suffered a severe electric shock while attempting to plug in a television set.

Jacqueline Priestman

An article published in the *New Straits Times*, dated June 8, 1985, reports an interesting case of HVS involving a 28-year-old mother of four from Stockport, Manchester, United Kingdom, named Jacqueline Priestman. In the article, Jacqueline is described as "the housewife who jinxed every electrical gadget she laid her hands on."[9]

The manner by which Jacqueline became an electric person is most curious. At the age of 22, while pregnant with her second child and caring for her daughter of 18 months, she and her first husband, Ron, had a huge argument. This prompted Ron to take off on his scooter. Just as he was leaving, Jacqueline screamed at Ron that she "hoped he broke his neck."[10] Later that day, Jacqueline's "wish" came true: Ron suffered a serious motorcycle accident in which he fractured his spine and neck. Before passing away in a hospital a month after the accident, he joked to the guilt-ridden Jacqueline that if he died he'd come back to haunt her.

Shortly after Ron's death, Jacqueline was taking a bath when the light bulb above her exploded, showering her with broken glass and causing her to cut her arm. She attributed the incident to a faulty bulb and thought no more of it. Later, another light bulb exploded at the moment she happened to be walking past the cupboard where Ron kept his motorcycle leathers.

Around this time, vacuum cleaners, record players, electric kettles, electric irons, washing machines, dryers, and other appliances and gadgets in the home kept breaking down or would start "acting funny" for no apparent reason. The radio would switch stations even though no one had touched it, and the television "would change channels or develop double images without warning."[11] Jacqueline was spooked by the electrical disturbances and became convinced that Ron's ghost had indeed come back to haunt her.

One of the strangest incidents that Jacqueline experienced occurred on the night her two daughters were christened. (Jacqueline chose to have both daughters christened on the same day.) She was anxious about the occasion, however, because Ron had not been a churchgoer and she knew he would not have approved of the christening. That night, she says, two cut glass goblets, each of which bore the name of one of her daughters, suddenly and inexplicably shattered while sitting on a window ledge.

By the time Jacqueline married her second husband, Paul, an electric fitter, the electrical disturbances were still taking place. Doctors she consulted failed to take her claims seriously, and the tranquilizers she was prescribed only worsened her condition. In addition to getting "[static] electric shocks constantly," Jacqueline experienced frequent headaches, passed out often, and suffered both bloating and constipation.[12] Eventually she underwent a nervous

breakdown and wanted to commit suicide. Because she “couldn’t make anything electric work,” Paul had to step in and take care of the cooking and cleaning.[13]

As her story began to attract media attention, she started to receive visits from reporters and psychic investigators, some of whom came looking for the alleged ghost. On one occasion Jacqueline became extremely angry with a female reporter because the reporter suspected her of being a fraud, at which moment the vacuum cleaner Jacqueline was holding suddenly “burst into flames.”[14] Both Jacqueline and the reporter were startled by the incident.

Drawing on his knowledge as an electric fitter, Paul took it upon himself to figure out the cause of the electrical disturbances and hopefully put an end to the problem. He eventually concluded that Jacqueline was solely yet unintentionally responsible for the disturbances and that the problem stemmed from a high accumulation of static electricity on her body. He noticed, too, that the problem became particularly severe when she was having her period or feeling stressed or upset.

Professor Roy Gough of Stockport conducted an examination of the broken electric rings from Jacqueline’s cooker. He discovered that the rings had failed not because a fuse had blown inside the cooker but because their contacts had been high-voltage welded. This finding reinforced Paul’s conclusion that Jacqueline had damaged the cooker and other devices by means of an electrostatic discharge effect.

Paul concluded that Jacqueline wasn’t so much generating the static electricity internally but picking up and retaining more static than is normal. He conducted an experiment whereby he connected 10 fluorescent lights in series and asked Jacqueline to hold the two ends of the circuit while she rubbed her feet against nylon carpet. All 10 lights lit up.

Apparently, Jacqueline’s condition was more or less cured when, as per Paul’s advice, she began to eat more fresh fruit and vegetables as well as plenty of poached onions. Under the assumption that onions absorb static electricity, Paul suggested to Jacqueline that she hold an onion in each hand while walking around the house. Jacqueline adopted the practice and it supposedly helped reduce the amount of static electricity absorbed by her body.

Is static electricity the whole answer?

Can the electrical disturbances that surrounded Jacqueline be explained in terms of electrostatics, and, if so, to what extent?

It’s a well-known fact that static discharges from the human body can damage sensitive electronic components. To eliminate static problems while fixing computers, IT technicians keep themselves grounded by wearing antistatic wrist straps and using other antistatic devices. Whereas to damage a sensitive electronic component inside a computer would require only a very small electrostatic discharge, to damage an electric cooker ring or vacuum cleaner would presumably require more static electricity than what the human body can normally deliver.

A capacitor is a device that stores an electric charge. The human body, when insulated, can store an electric charge, and therefore possesses capacitance. (Electrical capacitance is measured in farads [F]. The capacitance of the human body varies from less than 100 pF (picofarads) to more than 500 pF. [1 picofarad equals one trillionth of a farad.])

Your body is more likely to act as an effective capacitor if you’re wearing shoes that provide good insulation (for example, boots with thick rubber soles) than if you’re wearing shoes that provide poor insulation (for example, sandals). Also, having dry skin and being surrounded by

dry air would further serve to increase the capacitance of your body.

The surface of the human body can easily accumulate up to 25,000 volts of static charge. However, when the charge gets released all at once in the case of an electrostatic discharge, the resultant current is somewhere in the μA range. This explains why electrostatic discharges produced by the human body, though sometimes painful, are far from dangerous and certainly never lethal; the current would need to be much higher for there to be any kind of danger.

The question arises as to how Jacqueline became so highly charged with static electricity. Paul of course believed that she was picking up and retaining more static than is normal, which is equivalent to saying that her body was functioning as a highly effective capacitor. A more plausible theory is that the static didn't accumulate on Jacqueline's body but was generated internally—as appears to have been the case with the "electrified" convicts at Clinton Prison.

So we know that static electricity can account for some of the electrical disturbances caused by Jacqueline. But can it account for all of the disturbances? The answer is no. In particular, it's difficult to explain how static electricity was responsible for causing the two light bulbs to explode. There is simply no way to explain how a statically charged person can make a light bulb explode, especially without touching it. Plus, the first of the two incidents occurred while Jacqueline was taking a bath; meaning she could not have been statically charged.

And what about the shattered glass goblets? As with the broken light bulbs, it's difficult to account for this incident in terms of static electricity. In fact, the incident has psychokinesis (PK) written all over it. If we accept that at the time of the incident Jacqueline was still plagued by guilt over Ron's death, it's reasonable to assume that attending the christening amplified her guilt and that she herself caused the goblets to shatter by means of PK, albeit subconsciously.

While we're on this line of thought, it's important to acknowledge Paul's observation that the electrical disturbances became worse when Jacqueline was having her period or feeling stressed or upset. And let's not forget that what triggered the disturbances to begin with—that is to say, turned Jacqueline into an electric person—was the emotional impact of Ron's death.

The link between HVS and specific states of mind—in particular, stress—will be discussed in detail later. For the moment, consider the following account I received from a 50-year-old cleaner from New Zealand's Kapiti Coast, named Kate R:

> "This sort of thing happens to me quite a lot, usually when I am stressed about something. Street lights go on and off, radios turn to static if I am close to them, watches go backwards on me and digital watches only last a few days before the battery is drained. A compass is useless to me because it either just keeps spinning or it insists that true north is wherever I am. If I am really stressed I cause things to blow up—light bulbs either blow or explode out of their sockets. My kids won't let me touch anything electrical if I'm stressed because I have blown up 2 televisions, 2 fridges, a cake mixer, a vacuum cleaner and more light bulbs than I can count."[15]

Michael Shallis and the electric connection

Michael Shallis's *The Electric Connection* is by far the most comprehensive study of cases of electric people written to date. Originally a film editor and director, Shallis entered university as a mature-age student to study astrophysics. He later became a lecturer in the Department of External Studies at Oxford University. While teaching a course at Oxford University on the

nature of science and its impact on history, a student of his named Norma casually disclosed to him that she had a difficult relationship with electrical appliances and gadgets of all kinds. Intrigued by Norma's story, Shallis began to research the matter. He placed notices in magazines asking readers to send him accounts of "electrical sensitivity" (his term for HVS). The replies he received numbered in the hundreds.

Since Norma's story is what first inspired Shallis to research HVS, I feel it deserves mention here. Norma was raised in a rural home without electricity. At the age of nine, she was introduced to her first electrical appliance: a radio set owned by her uncle. Even though the radio was in perfect working order, she received a severe electric shock the moment her finger made contact with the radio set's Bakelite knob. The shock sent her flying across the room.

Although Norma recovered from the accident quickly, it proved to mark the beginning of her difficult relationship with all things electrical. The problem worsened after she married. She discovered that being in close proximity to the television set, the electric cooker, and other devices in her home made her feel ill, both mentally and physically, and seemed to drain her of her will and vitality. At times she came close to passing out. She also discovered that things of an electrical nature had a tendency to malfunction in her presence, so that, for example, light bulbs would suddenly "pop" as soon as she entered the room.

One of the most extreme cases of HVS discussed by Shallis is that of a housewife and mother of three named Sheila. Sheila can't touch her dog or shake anyone's hand, for fear that they will receive from her a painful static shock. She feels uncomfortable whenever her body accumulates a high static charge; first she experiences a headache, then she feels shooting pains down the right side of her body.

If, when charged, Sheila touches a light switch or some other object, the sparks that flash from her fingers can be up to two inches long. Sometimes, too, being highly charged causes her hair to stand on end, to the extent that it hurts as if being pulled. Shallis states that on one occasion Sheila was tested at an electrical research laboratory at Salford University. The tests revealed that Sheila "could naturally produce 10 times more static on her skin than the researcher was able to produce artificially."[16]

Like other electric people, Sheila frequently damages and disrupts electrical appliances and gadgets, in some cases without even touching them. On one occasion, she accidentally overheated and killed her tropical fish; this happened after she touched the fish tank thermostat. On another occasion, she suffered an electric shock while holding the iron. She saw a bright blue flash and was thrown hard against the kitchen wall. The entire base of the iron had blown out.

Throughout the years Sheila's destroyed numerous irons, tumble dryers, and other electrical appliances in her home. She does the same when not at home. She's caused cashier desktop computers to crash at her bank and deep freezer cabinets at her local supermarket to malfunction. Also, light bulbs often pop in her presence, and sometimes they explode when she tries to replace them.

It's obvious that at least some of the electrical disturbances that surround Sheila are purely the result of static electricity. Speculating on the manner by which electric people damage and destroy electrical appliances, Shallis suggests that the electric person first causes minor damage to the appliance (for example, melting of insulation around wires) by subjecting it to an electrostatic discharge; after which mains electricity produces the bulk of the damage. Yet, he notes, "this explanation does not account for all the cases; it does not explain the 'popping' of light bulbs or other examples where objects are not touched by the charged person, nor does it

account for the electrical devices that fail to perform correctly but do not 'blow up.'"[17] These phenomena, he suggests, seem to fall under the domain of PK.

In fact, his research revealed that many electric people possess psychic abilities of various kinds. Sheila, for example, can apparently perceive auras around some people, is often aware of who's about to call her on the telephone, and has seen at least two ghosts. One of the ghosts was that of her deceased grandmother. The other was that of a man who'd lived and died alone in the house where she and her husband resided after they first got married.

As for the debate over whether electric people become highly charged with static electricity because their bodies generate it internally or whether the static is simply external in origin, Shallis subscribes to the former explanation. Electric people, he says, "seem to have their own internal [electrostatic] generators."[18]

During a visit to Sheila's home, Shallis was intrigued to notice that the roof was being repaired for damage caused by lightning. This made him wonder "if there was any propensity for lightning to be attracted to electric people."[19] He explains: "The result of my research was surprising…. In the sample cases of electrical sensitives I have studied, 23 percent have been the victims of lightning strikes and one-fifth of those have been struck twice."[20] Shallis states that one of the subjects in his study experienced two lightning strikes to her home and a single strike to the school at which she worked. Another subject in his study said he became an electric person as a result of being struck by lightning twice.

It wasn't lightning or electric shock that caused Sheila to develop HVS. Rather, she became an electric person when, the same year her father died, she underwent an operation to remove a growth in her throat. She's had two operations in addition to the one to her throat; one was to remove an ovary; the other was a hysterectomy. (Considering that Sheila had been close to her father, it's possible that her emotional reaction to his death, rather than the operation to her throat, was responsible for her becoming an electric person. After all, Jacqueline became an electric person after suffering the loss of her husband.) Also, as a child Sheila was allergic or intolerant to 160 different foodstuffs, though today the number is much less.

Shallis discovered that Sheila wasn't the only allergy sufferer among his sample of electric people. Nor was she the only one who'd undergone a surgical operation in the past. In fact, she very much fit the profile of the typical electric person. He explains:

> "Eighty percent of my sample were women, with only a small fraction of them single, divorced or widowed. Nearly all of them suffered from static and the majority were allergy sufferers. Of all my subjects, more than seventy percent had had a surgical operation during their lives, many of these being major ones. Sixty percent of the subjects were affected by advancing thunderstorms, which included all the allergy sufferers… [A]lthough only twenty four percent of the subjects were made significantly ill in the presence of electricity, as many as thirty-one percent confessed to a real fear of electricity…."[21]

While, according to Shallis, only a small portion of electric people complain of adverse health effects from exposure to EM fields, most experience a number of unpleasant symptoms as an accompaniment to being highly charged with static electricity. Shallis lists these symptoms as headache, migraine, neck pain, nausea, disorientation, and a "feeling of being drained [of energy]."[22] Shallis discovered that many electric people experience the same set of symptoms,

though not as strongly, prior to a thunderstorm, and he states that most of the symptoms can be attributed to a build-up of positive ions in the air, as happens during a thunderstorm. He goes on to state that air ionizers, which produce and fill the air with negative ions, can be used to counteract these symptoms. (This is because the negative ions neutralize the positive ions.)

EHS and HVS: a comparison

What is an electric person exactly? And how does an electric person differ from someone with EHS? Or are the two conditions one and the same?

Based on the cases we've looked at in this chapter, it would appear that the following characteristics typify an electric person, or HVS sufferer: internal generation of static electricity (Wimshurst disorder); disruption of and damage to electrical devices and gadgets, partly by means of static electricity and partly by means of PK; multiple allergies and intolerances; and headache and other symptoms as an accompaniment to being highly charged with static electricity.

On the other hand, EHS is a condition whereby one feels ill from exposure to EM fields, with symptoms that include headache, difficulty concentrating, and reddening and burning of the skin. Another potential symptom is Wimshurst disorder, though this is more typical of HVS. EHS appears to involve a genuine allergic reaction (and hence an immune system response) to EM fields.

One major commonality between EHS and HVS is that, generally, both conditions are initiated by a single incidence of heavy exposure to electromagnetism. The three most common sources of exposure are lightning, mains electricity, and RF radiation. The culprit tends to be either lightning or mains electricity in cases of HVS, and RF radiation in cases of EHS.

If there's one main difference between HVS and EHS it's that most cases of HVS involve affecting things electrical, whereas most cases of EHS involve being affected by things electrical. Yet because EHS and HVS overlap to a significant extent, it would be erroneous to think of them as distinct conditions.

My research indicates that the incidence of HVS among the population is on the rise, and that, like its cousin EHS, the condition stems from living in an environment heavily polluted with artificial EM radiation. Much of the technology that gave rise to this pollution was created around the time of the Second World War. Nonetheless, there are plenty of cases of HVS that date back prior to this period, even as far back as the 19th century.

Caroline Clare: "A Human Electric Battery"

A perfect example of an HVS case from the 19th century is that of Caroline Clare of London, Ontario, Canada. The case was reported on June 23, 1879, in the St. John *Daily Sun*, under the title "A Human Electric Battery."

At the age of 17, Caroline developed a strange illness that eluded medical diagnosis. Her appetite waned and she rapidly lost weight. Her health eventually declined to the point where she ended up confined to bed. It was then that she began to slip in and out of mediumistic trances. First she'd undergo fits and spasms; then her eyes would become glazed and her body almost ridged; then she'd "discourse eloquently and give vivid descriptions of far-off scenes, far exceeding in their beauty anything which she had ever seen or presumably ever read of."[23]

The trances, which came and went over the period of a month, left Caroline physically and mentally drained. What made the phenomenon all the more odd is that Caroline was by nature a quiet and reserved young woman—not one to "discourse eloquently." Her condition began to improve as soon as the trances ceased, and before long she was healthy and energetic again.

Although Caroline completely recovered from her illness, it left her with electrical and magnetic abilities. The *Daily Sun* article describes her as "a perfect battery," and says she was "constantly giving off electric discharges."[24] If anyone shook her hand, or placed their hand in a pail of water with hers, they received a powerful shock. She was even able to send a sharp shock through 15 to 20 people joined by holding hands. Apparently, too, any object she touched remained statically charged for a very long time; anyone who then touched the charged objects would receive a painful shock.

As for Caroline's magnetic abilities, it is said that metal objects were powerfully attracted to her body but that wooden spoons and other non-metal objects showed no such attraction. Knives would jump straight into her hand whenever she attempted to pick them up. She could also suspend needles from the tips of her fingers. Apparently, metal objects clung to her body so powerfully that the only way to release them was to have someone pull the object away from her while she rubbed her arm in a vigorous fashion from the wrist upward.

In addition to her electrical and magnetic abilities, Caroline supposedly exerted a strange mental influence on human beings and animals. When she entered a room, for example, some of those present would suddenly feel sleepy; others ill and fidgety. Sometimes dogs would sit at her feet in a motionless trance for hours on end.

How long Caroline's abilities lasted, assuming they gradually weakened before disappearing altogether, remains unknown; the matter isn't mentioned in the article on her in the St. John *Daily Sun*. Apparently, the case attracted the interest of a number of medical men, including a Dr. Tye of Thamesville.

Angélique Cottin: the "electrical girl"

On January 15, 1846, in the village of Bouvigny, northwest France, 14-year-old Angélique Cottin, a solidly built girl of short stature and below average intelligence, was busy weaving silk thread gloves in the company of three other women when the oaken table at which they worked suddenly moved of its own accord. The women were naturally alarmed by the event, and for a moment work was suspended while they attempted to figure out what had caused it. As soon as Angélique resumed her place at the table, it moved again. Whenever she touched the table, it suddenly retreated from her, almost in the manner of a frightened animal.

When the phenomena repeated itself at work the following morning, the public concluded that Angélique was possessed by a devil and that she ought to be brought before the parish priest. The priest witnessed in his home an impressive demonstration of Angélique's abilities. A table retreated from Angélique the moment she touched it; and a chair on which she sat began to rock madly, as though trying to throw her off. The priest ruled out the involvement of witchcraft and was just as baffled by the phenomena as everybody else.

It wasn't long before Angélique's abilities became the focus of much public interest. Her parents, unable to resist the opportunity to benefit financially from the situation, organized demonstrations in which members of the public were required to pay a fee to see their daughter exhibit her abilities.

Angélique's parents arranged for their daughter—the "electrical girl," as she became known—to be brought to Paris in order to be studied by members of the French Academy of Sciences. The famous physicist François Arago (1786–1853), then secretary of the Academy of Sciences, headed the study. Angélique also participated in a series of preliminary experiments conducted by a Dr. Sanchon, whose detailed report on the matter, dated February 15, 1846, presents compelling evidence that her abilities were genuine and by no means the product of trickery.

In one experiment, Dr. Sanchon held a chair as firmly as he could using his foot and both hands. The moment Angélique sat down on the chair it was instantly "torn from my grasp."[25] In another experiment, which was repeated several times, a large and heavy dining table was suddenly "displaced and pushed" upon merely coming in contact with Angélique's clothing.[26] A similar experiment involved a large and heavy sofa. The moment Angélique sat down on the sofa beside Dr. Sanchon the sofa "was violently pushed against the wall."[27] Another experiment was performed whereby a chair was held to the ground by a number of strong individuals. After Dr. Sanchon had positioned himself on one side of the chair, Angélique sat down beside him on the other side of the chair. The moment she did so, Dr. Sanchon felt the chair "suddenly pushed from under me."[28]

Dr. Sanchon discovered that Angélique's abilities were most active during the evening from 7 to 9 o'clock. In his report, he argues that her abilities were due to a "gaseous current" or "fluid" that emanated from the front part of her body, particularly around the wrist and elbow region of her left arm. He goes on to state that her left arm continually quivered and contracted in an unusual manner and that it seemed a good deal warmer that her right arm. He also states that when Angélique caused items of furniture to be "thrown" it was because she'd touched them with her left hand as opposed to her right. Despite claiming that Angélique's left arm was unusually warm, he says the fluid that emanated from this region produced a sensation of cold. As he states in his report: "I distinctly felt a momentary breath upon my hands, similar to that made by lips."[29]

It's fascinating that Dr. Sanchon literally felt an energy of some kind emanate from Angélique's body. That he called this energy a "fluid" is perhaps due to the fact that electricity was once believed to behave in the manner of a fluid (hence the antiquated term "electric fluid"). Why he also called it a "gaseous current" might have something to do with an experiment he performed with Angélique in which she caused a piece of paper he'd balanced on his finger to be "blown away… as though by a sudden rush of wind."[30] He further claims that a small paper wheel placed vertically or horizontally on its axis was observed to rotate rapidly when brought in close proximity to the wrist or elbow joint of Angélique's left arm.

Angélique's ability to cause a paper wheel to rotate is reminiscent of a well-known exercise in PK that involves a simple device called a "psi wheel." A psi wheel consists of a four-sided paper star balanced on the pointy end of an upright pin. The idea is to cup your hands around the device while concentrating on trying to make it rotate. Not once have I achieved positive results with the exercise, though apparently many have. (There are many videos on YouTube that purport to show people using PK to make psi wheels rotate. But because the effect is so easy to fake—for example, by blowing gently on the paper wheel—it's impossible to tell if the videos are genuine.)

Much patience and practice is required before positive results appear, and even then it's impossible to produce the phenomenon on demand.

If we assume that "psi practitioners" emit some kind of energy from their hands when

successfully engaged in causing a psi wheel to rotate, it's easy to imagine what the result might be if this same energy were to "leak" from the body: PK effects of an unintended nature, particularly around those areas where the "leakages" exist. Could the strange phenomena produced by Angélique be the result of such an energy leakage? This possibility is strengthened by the fact that none of her PK effects were intentional or intelligently directed.

Was Angélique a poltergeist agent? A poltergeist agent is someone around whom poltergeist disturbances occur. They seem to subconsciously fuel the disturbances and tend to be repressed and troubled young women going through puberty. Although Angélique meets all the criteria for a poltergeist agent, the phenomena she produced are distinct from those of poltergeist effects. There is, nonetheless, a very tenuous boundary between being an electric person and being a poltergeist agent. We'll take a look at poltergeistry later in the chapter.

Like other electric people, Angélique's abilities fall into two categories: (1) those that can be explained in terms of PK; and (2) those that suggest the involvement of electricity or magnetism. The PK category would include such phenomena as the movement of furniture and other large objects. As for the second category, the strongest evidence we have that static electricity may have played a role in the case is that Angélique was able to attract sheets of paper with her hand.

Dr. Sanchon made the interesting discovery that Angélique's abilities ceased to function if her feet were prevented from making direct contact with the ground, either by having her seated on a chair with her feet raised in the air, or by placing a plate of glass or some other insulating material beneath her feet. It's possible these findings have something to do with static electricity, though it's hard to imagine how.

Continuing with our discussion of the second category, it is claimed that a magnetized needle suspended from the ceiling by a long piece of thread oscillated when brought in close proximity to Angélique's left arm. It is further claimed that Angélique received a powerful electric shock whenever she touched the north pole of a magnet with the end of her finger, but not when she touched the south pole. When Dr. Sanchon made it so that Angélique was unable to distinguish north from south on the magnet, she still managed to tell which pole was which.

Perhaps as a result of an improvement in her mental and physical health, Angélique's abilities eventually ran out of steam, disappearing altogether on April 10, 1846.

Streetlamp interference (SLI)

Having taken a detailed look at HVS, it's time we examined the closely related phenomenon of streetlamp interference (SLI). Allow me to describe a typical SLI experience. You've just exited the cinema after watching the remastered version of the classic film *Back to the Future*. You're alone, the hour is late, and the air's a little chilly. Having spent the last of your change on popcorn and candy for the movie, you realize you have no other choice but to walk the 1.5 miles home rather than catch the bus. This involves following the footpath that cuts through the park. Given the lateness of the hour, the park has a somewhat ominous vibe.

As you walk down the path through the park, you feel a little nervous and try to maintain a swift pace. Then something odd happens: One of the electric lamps that illuminates the path suddenly blinks out as you walk underneath it, only to turn back on the moment you've passed it. Being a rational-minded individual, you decide the experience was a coincidence and think no more about it. The following week, while walking home from work in the evening, the exact same thing happens again, only this time three lamps in a row blink out as you pass them.

What on earth just happened? Did you influence the lamps with the power of your mind? Or is there a mundane explanation for these events? Whatever the cause, experiences of this nature are common, with people in many different parts of the world claiming "that they involuntarily, and usually spontaneously, cause streetlamps to go out. Generally the effect is intermittent, infrequent and without an immediately discernable sequence of cause and effect."[31]

These words belong to the British paranormal scholar Hilary Evans, who, prior to his death in 2011, was the world's foremost authority on SLI. In addition to being a pictorial archivist, Evans wrote numerous books on Fortean subjects. He was one of the founding members of the UK-based Association for the Scientific Study of Anomalous Phenomena (ASSAP), "a scientifically-orientated educational and research charity and learned society dedicated to a better understanding of anomalous phenomena."[32]

Evans defined SLI as "an alleged phenomenon in which it is claimed that certain people, passing near a streetlight at night, cause it to spontaneously extinguish (or if off, come on)."[33] He believed it to be a "phenomenon in its own right."[34] Many of those who contacted Evans to inform him of their SLI experiences had never heard of the phenomenon until coming across his research, and had previously considered their ability unique or doubted their own sanity. To quote one SLIder: "I couldn't believe this was a phenomenon that others shared with me. I just thought I was nuts…."[35]

I am not a SLIder myself and when I first heard of the phenomenon it struck me as insignificant and boring, regardless of whether or not it had a paranormal basis. I quickly concluded that most, if not all, SLI experiences can be accounted for as a result of people perceiving connections that have no basis in reality. For, clearly, streetlamps can and do malfunction occasionally, and people are bound to walk past them at the moment these malfunctions occur. Only much later did I come to realize that we're dealing with a genuine and very intriguing mystery.

SLI experiences examined

Richard M., a professional magician in his 30s who lives in London, England, recalls the moment he became aware of his SLI ability. A 17-to 18-year-old teenager at the time, he was taking his dog for a walk when he noticed "that lights were going out when we walked under them and then flickering back on when we had passed."[36] He continues:

> "It didn't frighten me but I became conscious of it. I remember walking under them trying to make them go out but I couldn't. The moment I stopped willing it to happen, it would start again—like someone catching me out. I sort of anticipated it for a while and didn't really tell anyone about it. A few years ago, I noticed it happening again—the first time for a long time. Again, I was with my dog and this time we turned out a number of lights in a car park across the road. I told a close friend when I got home and he came out to watch from the other side of the road. As we walked around the park, they all went out as we passed under them, and then came back on when we had moved away… I seem to recall that both periods coincided with stress, some of it quite intense."[37]

It's noteworthy that the two SLI experiences described by Richard occurred while he was stressed. That a stressed or aroused state of mind encourages SLI ability is suggested by the testimony of a man from Harrogate, Yorkshire, England, named Dan C. Dan's history of SLI

began early one morning in 1991. Then 19, he was heading home from his girlfriend's house, where the two of them had engaged in a steamy "smooching session," when a streetlamp went out as he approached it. At first he attributed the incident to a "dodgy bulb." Yet the lamp did the same thing the following night. It was when the incident happened the third time that he "started to think something was up."[38]

Further strange incidents with the streetlamp followed. Dan explains: "Over the months, as I returned home from my girlfriend's house, the light would always do the opposite as to its original state, i.e., if it was off it would turn on and vice versa. After I'd passed the light-post, it would usually revert to its original state…."[39] Making the phenomenon all the more difficult to explain is the fact that Dan experienced SLI with multiple different streetlamps rather than only the one.

As was also true for Richard, Dan discovered the phenomenon behaved according to its own set of rules, largely resisting his attempts to control it. For example, on one occasion he attempted to demonstrate his SLI ability to doubting friends, only to make himself look foolish by failing to duplicate the effect. It eventually occurred to Dan that the phenomenon generally coincided with his being in a particular state of mind. He describes this as "quite tired, on edge, nervous of my surroundings…and I reckon my adrenaline levels must have been up."[40] He concludes: "This sort of explains why I couldn't 'perform' in front of my friends, having been in a relaxed situation. I have since shut my friends up as I have shown my ability on more than one occasion."[41]

The observation that a stressed or aroused state of mind encourages SLI ability deserves further comment. By "aroused" I mean sexually or emotionally charged. Of course, being stressed and being aroused are much the same thing. David P., a 48-year-old self-employed artist and photographer from Seattle, Washington, told me: "[SLI] seems to happen almost always when I am in a heightened state of mind, usually deep in thought about something troubling or stressful—but not always. Sometimes it happens when I am in an unusually good mood. Almost manic."[42] In addition to influencing streetlamps, David has "problems with electronic devices" such as "card-swiping machines at store check-outs, cameras and phones, computers etc."[43]

That the state of arousal produced by sexual thoughts or activity plays a role in SLI is nowhere more evident than in the case of Robert L., a psychologist from Great Falls, Montana. Robert says his SLI ability became especially apparent when, at one point in his life, he was dating a woman who lived across the other side of town from him, to whom he paid frequent evening visits. It was while making these nightly trips that Robert occasionally saw rows of streetlamps switch off as he passed them in his car, so that "each lamp I passed would go out as I was passing it."[44] Robert notes that the phenomenon always occurred on those evenings when he and his girlfriend had had intercourse. "On other evenings some lamps would go out but not like on the ones when our passions had been aroused."[45]

Whereas some SLIders say they affect only streetlamps, other say their ability extends to a whole range of electrical devices, from battery-operated wrist watches to railroad crossings to aircraft navigation equipment. Diana B., an office worker from Copperas Cove, Texas, belongs to the latter category. Not only do streetlamps dim and go out when she approaches them at night, but sometimes they also turn on when she approaches them during the day. Regular light bulbs and fluorescent lights also behave oddly in her presence, such as when she goes to a restaurant or enters the home of a friend. There have been occasions, too, when automatic garage doors have suddenly gone haywire on her, opening and closing quickly "in a crazy way."[46]

According to Diana, her ability to affect electrical devices becomes heightened whenever she's in a state of excitement or high energy. During these times, she can hold a compass in her hands and the needle will start to spin wildly, coming to a rest the moment she puts the compass down. Handheld tape recorders pose a special problem for Diana, either refusing to record when she wants them to or breaking down altogether. "I went through about 10 of them over a period of a couple of months. Once it was so bad it even wiped out what was on the tape."[47]

Diana says she "gets very charged with static electricity, so much so that sparks actually fly around me and if anyone else is close by the sparks will connect with them."[48] Similar comments from other SLIders include, "I build up static electricity like crazy,"[49] and "I seem to get more static shocks than other people."[50]

SLI as an aspect of HVS

Although I've chosen to describe Diana as a SLIder—since Evans refers to her as such in his book *SLIDERS*—it would be just as accurate to call her an electric person. In my opinion, all SLIders, regardless of whether they affect only streetlamps or both streetlamps and other devices, are electric people. SLI, then, is simply an aspect of HVS; it is not, as Evans concluded, a phenomenon in its own right. Of course, this still leaves us with the mystery as to why some electric people affect streetlamps only and others both streetlamps and other devices. The question we need to ask is this: What makes streetlamps "special" compared to other electrical devices?

Most modern streetlamps are of the low-pressure sodium-vapor variety. Low-pressure sodium-vapor lamps are filled with neon gas and a small amount of sodium. When first switched on, the neon gas is ionized, producing a red glow. This gives way to a steady monochromatic yellow as the sodium gas is ionized. The lamps automatically switch on at sundown, via the activation of a light-sensitive cell, or photocell. The cell is triggered again when sunlight returns at dawn, switching the lamps off. Generally, rather than each lamp having its own photocell, a single photocell is used to control a whole group of streetlamps.

Could the fact that many SLIders have issues with static electricity (in other words, suffer from Wimshurst disorder) in some way be responsible for the phenomenon? Although it's true that someone with a high static charge has the potential to interfere with electrical equipment, they cannot do so from a distance; only by means of contact. That a statically charged person would be able to influence a streetlamp mounted high above them is therefore extremely unlikely. And let us not forget that some incidents of SLI occur while the individual is seated in their car, a car being a crude form of Faraday cage, blocking static and non-static electric fields.

No doubt at least some incidents of SLI can be attributed to entirely mundane causes. Skeptics of SLI are keen to point out that when the bulbs in sodium-vapor lamps reach the end of their life they undergo a phenomenon known as "cycling," whereby they switch on and off every few minutes until a technician comes along and replaces the bulb. It can also happen that the bulb becomes slightly dislodged from its socket, so that even a minor vibration, such as that caused by a passing car or a person, is enough to make the lamp blink out for a moment.

Richard Wiseman, a professor of psychology at the University of Hertfordshire, England, cites "observer bias" as the reason for SLI. He explains: "Streetlamps are going on and off all the time because they are faulty or because their timers aren't set properly. People only have to walk under a couple of lamps going off to think that they might be the cause."[51]

Had Wiseman looked at the evidence properly, he'd realize that observer bias is not the whole story. When we eliminate this and other obvious explanations for SLI, we're left with the possibility of PK. In a 1993 document compiled by Evans and published by ASSAP, titled *The SLI Effect*, PK is explored as a potential explanation for SLI. Evans explains that streetlamps are designed in such a way as to be protected from operating at too high a voltage, whereby a cutoff switch is triggered the moment the voltage reaches a certain level. The lamp will remain off until reactivated the following evening. A similar scenario occurs when the voltage drops below a certain level. Evans puts forward an intriguing theory: that the "force" at work in SLI operates by affecting the voltage of the current, most likely by causing a surge in voltage that triggers the lamp's internal cut-off switch. He explains:

> "To perform this feat, SLI would have to be an electro-dynamic force, somehow generated within or through the human biological system, and somehow externalized into the neighbouring environment, where it will act on any appliance which happens to be vulnerable… [T]here is good reason to think that [streetlamps] are particularly sensitive compared with other types of equipment: this could be because they operate at close to the critical level, or because it is not normally considered necessary to provide them with substantial shielding."[52]

In my opinion, this is the best explanation for SLI that has yet been advanced. It supports my view of SLI as an aspect of HVS. As to the question raised earlier about what makes streetlamps "special" compared to other electrical devices, the answer would seem to be that streetlamps are simply more vulnerable to PK influence than other electrical devices. Presumably, too, SLIders who affect streetlamps in addition to other electrical devices possess greater PK ability than those who affect streetlamps only.

It's also possible that, due to aesthetic reasons, SLIders "choose" streetlamps as targets for PK ability in preference to other devices. If we accept that SLI is caused by the subconscious mind, perhaps as an outlet for repressed emotions, it makes sense that the subconscious mind would prefer to influence a streetlamp than, say, a soft drink vending machine. Watching a can of Pepsi get lodged in a vending machine is fairly boring compared to watching a streetlamp blink off the moment you pass it late at night. The subconscious mind communicates in a symbolic fashion, and streetlamps have greater symbolic significance than do vending machines and many other devices.

In accordance with the subconscious mind explanation, SLI seems only to occur when the SLIder isn't thinking about it or willing it to happen. To quote Randall S., from Denver, Colorado, who experienced SLI as a student while walking around campus: "Oddly, once I began to change my thoughts to the lights going out, they would stop going out."[53]

If SLI is indeed an aspect of HVS, we would expect to find incidents of lightning strike and electric shock in cases of SLI. The aforementioned David P., who's experienced SLI since his teens, has had a number of close brushes with lightning, the first of which occurred at the age of seven when lightning struck the house and knocked him to the floor. "Three times since, I have been close enough to lightning to be knocked down (but never struck directly, thank God)," he told me.[54]

Corby F., a 40-year-old auto mechanic from Los Angeles, California, also had an encounter with lightning as a child and nowadays experiences SLI. He explained: "When I was a child, I was indirectly struck by lightning; it hit a tree and an awning that I was touching. I was on dry

pavement and unharmed, but felt the effects."[55] He added: "I was a teenager before noticing the streetlight phenomenon, mostly because I grew up in the country without streetlights… [U]sually I am driving when it occurs."[56]

Specific mention is made of electric shock in several of the cases of SLI presented in Evans's book *SLIDERS*. One such case concerns a technician from Plano, Texas, who said he first began to experience SLI after undergoing a serious accident with an electric welding machine, which left him paralyzed for two weeks and inflicted long-term damage. Another such case concerns a 17-year-old student from Baker City, Oregon, named John S. John said he had his first SLI experience at the age of nine, around which time he also had an accident while swimming in which he received a severe electric shock from grabbing hold of an electric cable. (No mention is given as to which event occurred first, though presumably the electric shock did.)

Is there a connection between SLI and EHS? The following quote from Evans's book *SLIDERS* indicates in the affirmative: "Quite a few SLIders mention having a sensitivity to everything electrical, but only as a possible side-effect."[57] That SLI and EHS are connected makes sense in view of the fact that SLI is an aspect of HVS. As an example of a SLIder who also suffers from EHS, Evans presents the case of a teacher named Sarah B., from Croydon, Victoria, Australia. Sarah, whose EHS symptoms include exhaustion, mental fatigue, disorientation, and sleeplessness, suspects that her having EHS and her ability to affect streetlamps are related.

Poltergeistry

Poltergeistry is one of the most common, enduring, and closely studied of all paranormal phenomena. I doubt there's a single parapsychologist alive today who doesn't think poltergeists are genuine. The question is not whether poltergeist activity is real, but rather what causes the activity.

Most experts view poltergeist happenings as instances of recurrent spontaneous psychokinesis (RSPK), a term coined by the parapsychologist William Roll (1926–2012). Saying that poltergeist disturbances are caused by RSPK is equivalent to saying that the subconscious mind of the agent is responsible.

In addition to the RSPK theory, there is the less popular "spirit hypothesis." (*Polter* is German for "noise" or "racket" and *geist* means "spirit.") The theory states that poltergeist cases occur when one or more mischievous and boisterous spirits attach themselves to a vulnerable human being (the agent), whose energy they draw from in order to throw objects about and produce other physical effects.

Proponents of the spirit hypothesis include Colin Wilson and Guy Lyon Playfair. I myself subscribed to it once. However, since the existence or otherwise of spirits is such a thorny issue, there are no tools available with which to investigate the spirit hypothesis from a scientific angle. The RSPK theory is actually more exciting that the spirit hypothesis because it suggests that human beings are capable of remarkable feats of mind over matter, but that these abilities normally lie hidden and untapped.

Earlier we acknowledged that there is a very tenuous boundary between being an electric person and being a poltergeist agent. For the sake of comparison, it would help to take a look at a few poltergeist cases. So as to remain in keeping with the theme of this book, each of the three cases I've selected for our discussion features an abundance of electrical effects.

The Rosenheim Poltergeist

The Rosenheim Poltergeist case is named after the location in which it occurred: the Bavarian town of Rosenheim, Germany. The disturbances began in late-November of 1967, in the office of a lawyer by the name of Sigmund Adam. Light bulbs exploded in their sockets, showering the office with splinters of glass. Neon tubes unscrewed themselves from their sockets. Hanging light fixtures swung back and forth on their own. Electrical fuses blew with no apparent cause. The photostatic copiers continually leaked developer fluid. And the telephones went haywire. Sometimes all four telephones in the office would ring simultaneously with no one on the other end of the line. It was common for calls to be interrupted for short periods or to cut off entirely. Worst of all, the office was billed for hundreds of calls that the office employees swore they hadn't made.

Hoping to get to the bottom of the matter, technicians from the local utility company visited the office to install monitoring equipment on the mains power supply to detect any unusual fluctuations. The equipment recorded deflections of up to 50 amps through the fuses. Amazingly, the fuses remained unaffected by the deflections; they hadn't blown as they should have. The deflections tended to coincide with disturbances observed in the office and they continued even when the office was disconnected from the mains power supply and connected to a generator.

Furthermore, after technicians from the telephone company had installed monitoring equipment on the telephone lines to keep track of outgoing calls, it was revealed that a huge number of calls had been made to a time-announcement service number. The number had been dialed as rapidly as six times a minute. Again, office employees insisted that the calls weren't theirs. And besides, some of the calls had been made when no one was in the office using the phones.

On December 1, 1967, Dr. Hans Bender (1907–1991) of the University of Freiburg, a parapsychologist and seasoned poltergeist investigator, arrived at the office to investigate the strange goings-on, which by that time were still in full force. He and his team set up their own equipment to monitor deflections in the power supply. They managed to rule out such causes for the deflections as variations in the mains voltage, electrostatic charging, demodulated high frequency voltages, external static magnetic fields, and ultrasonic and infrasonic effects (including strong vibrations). They concluded the poltergeist case was genuine and that no form of trickery was involved.

By this stage the disturbances had multiplied to include such PK phenomena as paintings rotating on their hooks, plates jumping off walls, and cabinet drawers opening by themselves. At one point, a heavy storage shelf, which weighed nearly 400 pounds, moved away from its position against the wall.

It soon became apparent to Bender and his team that the disturbances focused around a 19-year-old unmarried secretary named Annmarie Schneider. The disturbances occurred only during work hours, and only when Annmarie was present. Annmarie, who'd worked in the office since she left school in October 1965, was a tense and unhappy young woman who detested her job. In short, she possessed all the qualities typical of a poltergeist agent.

In a 1974 newspaper article that makes mention of the Rosenheim Poltergeist case and its agent Annmarie Schneider, Bender commented: "[Poltergeist] disturbances come from an actual emotional disorder. These people [poltergeist agents] are usually young, often adolescents, with very intense conflicts, especially sexual ones, and a very low tolerance of frustration. What happens is that quite unconsciously—they are not aware of it—the emotional conflict is

converted into PK which causes the phenomena."[58]

The poltergeist disturbances in the office ceased when Annmarie was let go by her employer. The disturbances resumed at her next place of employment, though they died out quickly and never returned. Around the same time she was sacked from the law office, her fiancée broke off their engagement. The two used to frequent a bowling alley together, where it was noticed that Annmarie's presence had a disruptive effect on the electrically operated equipment. This so disturbed Annmarie's fiancée that he decided he didn't want to marry her. Bender offers an interesting perspective on the matter: "My own interpretation is that Annmarie unconsciously knew he wasn't the right man for her and used her PK to discourage him."[59]

A case from Poland

This poltergeist case occurred in the mining town of Sosnowiec, in southern Poland. It began on the night of April 4, 1983, in the tiny apartment occupied by 13-year-old Joasia Gajewski and her mother and father. Despite being somewhat shaken by the recent death of her grandmother, to whom she'd been close, as well as going through puberty, Joasia was a normal adolescent leading a perfectly normal life. She spent the evening watching television with her mother and visiting grandfather. Her father, a plumber at the local steelworks, was absent that evening due to working the nightshift. When it came time to retire for the evening, it was decided that the grandfather, who'd chosen to stay the night, would share the sofa bed in the parlor with Joasia and that her mother would sleep on the cot in the kitchen.

All was peaceful in the apartment until 3 a.m., whereupon the grandfather felt something fall on top of him. The object proved to be a straw mat that hung over the back of the sofa. When he tried to place the mat back where it belonged, it tore itself out of his hands and began to dance around. At first he assumed that Joasia was playing a trick on him; however, he noticed she was asleep and couldn't have been responsible.

Minutes later, all hell broke loose in the apartment as objects such as plates and glassware began to fly around in all directions. Some of the plates and glassware smashed hard against the walls. Joasia received several cuts to her body from being struck by fragments of broken glass. The "poltergeist" also caused windows to rattle and furniture to shake. The three wasted no time in fleeing the mayhem, taking refuge in the upstairs apartment of neighbors Jan and Gertrude Jach.

Later that evening, alerted by noise from below, Jan, Joasia, and her mother rushed downstairs to the apartment. Peering in from the safety of the doorway, Jach saw "glasses, plates, pots and a lot of other objects smash into the wall," as he later described it to a Japanese journalist. "The noise was unbelievable…. Those dishes must have been flying incredibly fast because you couldn't see them until they fell."[60] Scared of what might happen if they stuck around, the three ran back upstairs to Jach's apartment.

That night, Joasia complained of a headache and fever that had started the previous day. She ended up spending the rest of the night at Jach's apartment. Her illness remained for a number of days. Meanwhile, the poltergeist phenomena, which still consisted primarily of objects being thrown violently around the apartment, gradually intensified. It soon became clear that Joasia was the poltergeist agent.

That Joasia became ill around the same time the poltergeist phenomena erupted cannot be a coincidence. Interestingly, friends and family members observed that her body became highly charged with static electricity in the weeks prior to April 4. They even described her as

"crackling" with sounds similar to those produced by fingers snapping. Later, after coming to the attention of Polish scientists, including a physician by the name of Dr. Eustachiusz Gadula, Joasia underwent a series of intensive medical and psychological tests. The tests revealed a number of peculiarities with respect to the teenager's health, including that her body was indeed highly charged with static electricity. Indicating that this was a case of Wimshurst disorder and not regular static build up is that her body remained highly charged even when grounded. Also, thermographic studies showed that Joasia exhibited unusually wide and rapid changes in her overall body temperature, and, further, that she possessed unusual thermal spots (warm areas) around her head, toes, fingers, and slightly above her solar plexus. (As the reader will recall, a very similar phenomenon was observed with respect to Angélique Cottin.)

While studying Joasia, Dr. Gadula and his team witnessed a number of remarkable incidents of what appeared to be genuine PK of both a spontaneous and controlled nature. On one occasion, they watched in amazement as the armchair on which Joasia sat cross-legged (meaning her feet weren't touching the ground) began moving around. The chair continued to move even after Joasia had removed herself from it. At one point it lifted off the ground and rotated rapidly. An attempt by three men to hold the chair down proved futile; the chair overpowered them.

As for controlled PK, Joasia was apparently able to bend metal cutlery in a similar manner to the famous Israeli-born psychic Uri Geller. Although the researchers saw her bend numerous pieces of cutlery, they failed to capture the phenomenon on film; Joasia was unable to perform when the camera was rolling. Assuming the phenomenon was genuine and not a trick, it supports the theory that the powerful "energies" at work in poltergeist cases can to some extent be harnessed by the agent and directed toward more constructive tasks than the senseless trashing of homes.

The poltergeist disturbances that surrounded Joasia, along with her metal bending abilities, persisted until she was at least 20, making this one of the longest running poltergeist cases in history. It's been suggested that because Sosnowiec is located in an area rich in minerals and geological fault lines, the poltergeist phenomena was caused, or at least promoted, by some form of seismically-induced EM activity.

An "electromagnetically-induced pseudo-poltergeist"

So far we've looked at poltergeist cases in Germany and Poland. This case is also European. It occurred in mid-2002 in the West Midlands region of the United Kingdom, in a town house occupied by a family of four: parents Ronald and Penny and their children Mary (aged 3) and Charles (aged 12 months). The case is unique in that it doesn't belong in the category of a typical poltergeist haunting nor in the category of a typical ghost haunting; rather, it shares elements of both. It was investigated by members of the UK-based organization Parasearch, which is affiliated with both ASSAP and the Society for Psychical Research (SPR). Formed in December 1986 by David Taylor, Parasearch takes a scientific approach to cases of alleged paranormal phenomena, which includes working with consultants in physics, biology, archaeology, and other disciplines.

The complaints made by the family included a persistent sense of presence, a feeling of being watched, and electrical disturbances such as the sudden activation of battery-operated toys. Additionally, Mary kept waking up a 3 a.m. in a distressed state and mentioned on each occasion that she'd been visited in her room by a female apparition. There were times when Mary, distressed by the apparition, would make such comments as, "No, I'm not going with you. I'm

staying with my daddy."[61] Although many of the disturbances concerned Mary, the investigators identified Ronald as the primary focus and uncovered details regarding his past that suggested he might have EHS or HVS. He'd been struck by lightning once as a child and severely shocked twice by mains electricity as an adult.

As the disturbances began to intensify, the family members felt terrorized and reported hearing loud banging and hammering sounds emanating from the ceiling. On one occasion they saw a "bolt of lightning with five arcs discharge itself from one wall to the other."[62] (We can assume this was a large electrostatic discharge though not an actual bolt of lightning.) Spookiest of all, they witnessed on one occasion the child safety gate at the top of the stairs swing back and forth of its own accord.

As part of their effort to determine what might be causing the disturbances, the investigators inspected the property for strong EM fields and ultrasonic sounds. They found "strong electromagnetic and ultrasonic sources both in the older child's [Mary's] bedroom and in the parents' room." Having traced the problem to the central heating system, they discovered that, because it hadn't been earthed, it acted as a receiver and transmitter for radio signals. About a month after the heating system had been earthed (which cancelled out the incoming radio signals), the family said the poltergeist phenomena had more or less ceased, save for the occasional unexplained noise, and that Mary was no longer being visited at night by the female apparition. The investigators concluded: "It is our belief that this case is an example of a low-level, electromagnetically-induced pseudo-poltergeist that is interacting with at least two individuals (Ronald and Mary)."[63]

Although there's no way of knowing for sure whether the poltergeist phenomena were "electromagnetically induced," the fact that the phenomena virtually ceased after the heating system had been earthed and the house consequently lowered of EM pollution certainly suggests as much. That Ronald had been struck by lightning as a child, as well as suffered two severe electric shocks, making him a likely candidate for EHS or HVS, also points toward an EM explanation.

As we'll discuss in detail in the next chapter, it's been shown that both natural and artificial EM fields can induce paranormal and mystical experiences in certain susceptible individuals. Thus, it's possible the female apparition seen repeatedly by Mary was hallucinatory in nature and due to EM factors. This is not to suggest that the entire poltergeist haunting was one large hallucination, or that the case can be explained in terms of electromagnetism alone. The unusual movement of the child safety gate and the sighting by the family of a "bolt of lightning" inside the house indicate, respectively, the involvement of PK and electrostatic effects.

7 The Fifth Force

The remarkable case of Sarah S

In his book *The Poltergeist Phenomenon*, Michael Clarkson describes the remarkable case of a woman in her 40s from Ottawa, Canada, named Sarah S., who, like Joasia Gajewski, is able to produce PK in addition to RSPK. Sarah's PK talent lies not in bending spoons but in causing the rotation of a psi wheel, or pinwheel. She and her abilities have been the focus of considerable interest and study by a team of scientists that include the respected neuroscientist Michael Persinger of Laurentian University in Sudbury, Ontario, Canada, and the late William Roll. "I think her psychokinesis is genuine," Roll commented. "I think she is a very sincere individual and has extraordinary ability in PK."[1]

"Rattling plates, noises in the night, car malfunctions, [and] popping light bulbs seem to happen all the time around me," explains Sarah, who refers to herself as an "RSPK agent."[2] These and similar types of disturbances generally only happen when she's feeling stressed or emotional, such as when she and her husband are going through a difficult period in their relationship. On one occasion in May 2010, she was seated in the car beside her husband when he developed road rage after another driver took his parking spot. Seeing her husband react this way caused her to become frightened, whereupon the radio in the car turned to static, the steering wheel became difficult to control, and the car's signal lights began blinking on and off on their own.

"I get afraid when hubby is angry," she said. "It doesn't matter if he is yelling at another driver or getting upset at sports on TV…it sets off my RSPK. Glasses vibrate and light bulbs pop. I'm afraid of my RSPK hurting my husband."[3] It's not uncommon for banging sounds to emanate from the walls of their bedroom after she and her husband have had an argument. Yet this only happens when she's asleep; the banging sounds cease the moment she wakes up. (Banging, rapping, and knocking sounds are a distinctive feature of poltergeist hauntings and can also occur during séances.)

Sarah's alleged abilities include being able to perceive "lights" of various colors and glows around people. She says the lights are akin to the Northern Lights and that they vary in appearance depending on the mood and personality of the individual concerned. (As I explained earlier, the human body is surrounded by an EM field; and it would appear that "auric sight" is simply a form of visual-based magnetoception.)

Associated with her ability to perceive "auras" is her ability to pick up other people's thoughts and feelings. The latter ability tends to be activated when she's sitting in close proximity to others on the bus. She explains: "I hear a lot of noise coming from them and it makes me uncomfortable; I can pick up too much information from them—their emotions, whether they're hungry or not, and images of what they've been doing that day."[4] Being a medium of sorts, Sarah has seen ghosts on numerous occasions and also hears the voices of a number of "imaginary friends," two of whom are male and help her to cope with her unusual

experiences.

A traumatic experience

Sarah's abilities were "awakened" by a traumatic experience she endured in 1995. One night a fight erupted between her and her first husband, during which he threatened to kill her. She explains what happened next: "I was afraid for my life but suddenly our house came alive. The lights came on and off; radios and TVs came on and off. There were weird lights that kind of looked like people."[5] Scared out of his wits, her husband ran out the door. He didn't return home, so she ended up filing a missing persons report. Two weeks passed before the police managed to find him. Sarah couldn't help but remain fearful of her husband even though he apologized and pleaded for her forgiveness. He died shortly after their marriage ended, despite the fact he'd been reasonably young and healthy at the time.

Although Sarah feels that RSPK saved her life that fateful evening in 1995, she remains haunted by the possibility that she somehow contributed to her first husband's premature death. "I know that there is no way to know what really caused his death, but a part of me worries that maybe my fear of him played a role in what happened."[6] (The story is uncannily similar to what happened between Jaqueline Priestman and her first husband.)

From extrovert to introvert

In 1993, some two years prior to the traumatic experience she endured at the hands of her first husband, Sarah had a near-death experience (NDE). One winter's day, while driving home from an outing with her pet dog, the radio in her car emitted static and the music it was playing suddenly died. Oddly, the radio had behaved in a similar manner earlier in the day along the same spot on the highway. Before she had time to blink, her car skidded out of control over a patch of black ice and was then sliced in half by an oncoming truck.

During the NDE that followed, Sarah found herself in the company of her deceased grandmother, in a heavenly place filled with a "soft beautiful light."[7] She was told by her grandmother that she'd "have to go back."[8] When Sarah woke up in hospital, she was informed she'd been in a coma for approximately two days. Her injuries included numerous broken bones and a moderately severe traumatic brain injury (TMI) on her right side. Much to the surprise of doctors, she made a remarkable recovery.

It's been suggested by Roll that Sarah's 1993 accident and resultant head injury—in combination with a previous serious head injury she sustained as a young child—altered her brain in such a way that it "knocked out some systems and enhanced others" and that this is how she acquired her PK abilities.[9] Roll added that there might have occurred in her brain a shift in ability from the left hemisphere (which controls the right side of the body and is scientific and analytical in nature) to the right hemisphere (which controls the left side of the body and is creative and intuitive in nature). That the brain damage caused by the 1993 accident transformed Sarah from an extroverted "party girl" to a moderate introvert, as confirmed by personality tests, seems to offer support for Roll's theory.

Visit to Sudbury

In April of 2010, Sarah paid a visit to Persinger's neuroscience lab in Sudbury. There, throughout the course of two days, she participated in a series of rudimentary tests, under the

supervision of Persinger, Roll, and colleagues. The results of the tests are presented in a "case report" published in 2012 in the peer-reviewed journal *Neurocase*. For the duration of the tests, Sarah sat either inside or outside of an acoustic chamber that doubled as a Faraday cage. An EEG machine was hooked up to her head to monitor her brainwave activity. Her primary task was to focus on and attempt to rotate a psi wheel.

On the first day, Sarah was unsuccessful in her attempts to influence the psi wheel. That night, however, while back at her hotel room, she managed to make the psi wheel rotate for a period of 10 to 20 seconds. One of the experimenters (not Persinger or Roll) was present during the demonstration and used a portable EEG to record her brainwaves. "[He] was truly and honestly happy to see the wheel move," she commented.[10] For the short period during which she appeared to influence the psi wheel, her EEG recording showed "increased coherence between the left and right temporal lobes [of the brain] and concurrent activation of the left prefrontal region."[11] This is a significant finding, as increased brainwave coherence is associated with meditation.

Persinger, though hardly convinced that Sarah possessed PK abilities, was nonetheless intrigued by her brain. He said: "She has a unique brain with EEG patterns I have not seen previously and are clearly not in the obvious scientific literature."[12] He added: "She does some interesting phenomena, but we need more proof. Unless she can move the wheel when it's under glass, for example, it's insufficient."[13]

"It's kind of an electrical feeling"

Since the tests at Sudbury in April 2010, Sarah has continued with the psi wheel exercise. She says her ability to influence the wheel has improved with practice, and that the exercise is beneficial because it helps her manage and control her RSPK. "I'm trying to focus on using up the energy in harmless ways," she explained. "It isn't a cure, but it is helpful."[14]

According to Sarah, often she has more success at influencing the wheel when she isn't "really trying," versus when she puts in a great deal of effort. She says she "almost [has] to ignore the wheel before it moves. But then I can feel it in my body when the wheel is moving. It's kind of an electrical feeling. My hands get pin-prickly. I see lights around the wheel and sometimes I look at that."[15] Apparently, she's able to make the psi wheel rotate almost every time she attempts to do so. She can also make it rotate when covered by a glass or jar, though only for very brief periods. That the phenomenon is harder to achieve through glass suggests that the form of energy involved—which is unlikely to be electromagnetism—has difficulty penetrating certain materials, glass being one of them.

It would seem that Sarah suffers from EHS in addition to being an electric person or poltergeist agent. Clarkson, who interviewed Sarah at length, commented: "When she goes near power lines, she feels disoriented, and yet thunderstorms can quiet her. As well, geomagnetic storms can give her headaches, nausea and even hives."[16] As evidence that Sarah is highly sensitive to changes in the geomagnetic field, Persinger and his colleagues found that her anomalous experiences tend to correspond to periods of increased geomagnetic activity. Furthermore, she is allergic to some drugs and painkillers, has witnessed ball lightning on two separate occasions while living in the same house, and when she touches others it's common for them to receive from her a static shock. In her own words: "I zap people all the time…"[17]

RSPK and the fight-or-flight response

It's significant that Sarah's RSPK is set off by stress and fear, both of which involve activation of the fight or flight response. In fact, it was activation of the fight or flight response, from when her first husband threatened to kill her in 1995, that served to awaken her RSPK abilities. And let's not forget that SLI—which could be categorized as a form of RSPK activity—is also associated with stress (and to a lesser extent fear) and hence with the fight or flight response. Remember, the fight or flight response is a product of the ANS, while the ANS is affiliated with the subconscious mind.

Can we conclude that psychic information enters the subconscious mind via the ANS? Actually, there is some evidence for this. Experiments conducted by the parapsychologist Dean Radin show that the ANS responds to events shortly before they happen—a phenomenon he labels presentiment—as revealed by changes in skin conductance (increased sweat), heart rate, blood oxygenation in the brain, variations in the size of the eye's pupil, and other autonomic functions.

In a typical presentiment experiment, the subject sits in a chair in front of a computer screen while their skin conductance (electrodermal activity) is monitored. (The electrical conductance of the skin varies depending on how much you sweat, which in turn varies depending on your level of arousal; the more aroused you are, the more you sweat.)

A series of randomly selected images are presented on the screen, some of which are emotional (scenes of sex or violence) and the rest calm (scenes of nature and the like). You'd expect the participant to exhibit higher electrodermal activity for the emotional images than for the calm images, and this is precisely the outcome. Yet here's what's odd: even before the images have been displayed their electrodermal activity is higher for the emotional images than for the calm images. Again, this demonstrates that the ANS responds to future events and, by implication, that psychic information enters the subconscious mind via the ANS.

As we discussed previously, one mechanism by which artificial EM fields adversely affect our health is by targeting the ANS in such a way as to activate the fight or flight response on a long-term basis, so inducing a state of chronic stress. The nervous system—and in particular the ANS—is the part of the body that receives the most damage in the event of a lightning strike. Also, as we know, lightning strike, severe electric shock, and other forms of heavy exposure to EM energy can lead to the development of HVS/EHS. Presumably, then, HVS/EHS is a consequence of disruption or damage to the ANS. No wonder the fight or flight response plays a crucial role in PK and RSPK, especially given the ANS's affiliation with the "psychic" subconscious mind.

Clarkson, who's written a number of books on fear and the fight or flight response, posits in his book *The Poltergeist Phenomenon* that both PK and RSPK are "rare characteristics of fear energy and the fight or flight system."[18] He elaborates:

> "In most…poltergeist cases…the poltergeist agent seems to be suffering from stress, anger, fear, or trauma. It follows that the person's sympathetic nervous system [the part of the ANS that activates the fight or flight response], and perhaps the fight or flight response, would kick in. Physical examinations of some poltergeist agents often show high levels of adrenaline and noradrenaline in their nervous systems, which are traditional fight or flight hormones. If the agent is showing unconscious hostility toward someone in the home, then his or her fear energy would be directed at that person. If he

or she has PK powers, then it might manifest itself in objects moving."[19]

Of significance to Clarkson's theory is the fact that people under extreme stress or fear have been known to perform feats that seem almost superhuman—for example, freeing a trapped loved one from under the wreckage of a car, or outrunning a ferocious animal. Another effect is a state of heightened awareness whereby time seems to stand still. In fact, what seems to separate high performance athletes from mediocre athletes is that the former are able to achieve such a state—what they call being "in the zone"—without too much difficulty, whereas the latter are not. We've all experienced a period of being in the zone at least once or twice in our lives. It can happen during activities that aren't necessarily physical, such as while sitting for an important exam.

Matthew Manning

Having taken a thorough look at Sarah S., it's time we turned our attention to Matthew Manning, another individual with supposed PK abilities. Today, Manning is a world-famous healer whose clients have included such famous persons as John Cleese and Van Morrison. His first book, *The Link*, sold more than one million copies and made him almost as famous as Uri Geller. In fact, because of his ability to bend spoons and other metal objects using PK, for a while he was hailed by the press as "England's Answer to Uri Geller."

Matthew Manning demonstrates his PK ability to Professor Brian Josephson during the Toronto experiments in 1974. Photo courtesy of Matthew Manning.

Yet it would be wrong to draw too close a comparison between Manning and Geller. In terms of personality they're very different. Whereas Geller is an extroverted showman who relishes controversy, Manning is an introvert who's always shunned the limelight. There is nothing to indicate that Manning is anything other than the "real deal," and not one of the reputable scientists under whom he participated in tests regarding his abilities detected the slightest hint of fraud on Manning's part.

Poltergeist happenings

Manning was born in 1955 to reasonably wealthy parents. In February of 1967, at which time he was 11, he and his family were living in a modern detached house in Cambridge. On the morning of February 18—a Saturday—his father entered the living room to discover that the silver tankard that normally sat on the shelf was instead lying on the floor on its side. Had the tankard fallen from the shelf it would have shown signs of damage, yet it didn't; someone, it seems, had placed it on the floor. Manning and his younger brother and sister denied having moved the tankard. A number of days later, Manning's father, who was always the first to enter the living room in the morning, again found the tankard lying on the floor on its side. The same thing happened again the following morning. That night, unbeknownst to Manning and his siblings, Manning's parents sprinkled around the tankard a ring of talcum powder. The following morning, the tankard was again on the floor, although the ring of talcum powder was completely undisturbed—whoever or whatever had displaced the object had done so by lifting it vertically from the shelf.

Before long, other objects in the Manning household, including a vase and a pottery dog, began to show up in odd locations. Next, inexplicable knocking, creaking, and tapping sounds were heard by members of the family in all parts of the house, both throughout the day and night. Eager to get to the bottom of the strange goings-on, Manning's father contacted Dr. George Owen, at the time a lecturer in genetics at Trinity College, Cambridge, and Secretary of the Cambridge Psychical Research Society. After conducting a thorough investigation of the matter, Dr. Owen concluded that the "[poltergeist] happenings are genuine, and not caused by trickery."[20] He identified Manning as the RSPK agent, stating that "the force, whatever it may be, resides principally in Matthew."[21]

More poltergeist happenings

The poltergeist disturbances eventually died out and were quickly forgotten. However, in mid-1971, at which time Manning was 15 and living with his family in an old house in Linton near Cambridge, called Queen's House, the disturbances started up again. This second phase of poltergeist activity was more powerful and varied than the first. Again, objects in the house began to show up in odd locations. The "poltergeist" enjoyed surprising the family by performing "balancing tricks" with various items, such as by placing a broom across the horizontal handrail of the staircase. Furthermore, beds were found stripped and overturned, childish scribbles and drawings done in pencil appeared on walls throughout the house, large pools of water and other liquids appeared on the floor, and objects were picked up and thrown through the air.

Perhaps the strangest phenomenon of all was the discovery of "apports" (apparently materialized objects) on the landings and staircase of the house. These included an antique loaf of bread (thought to be 70 years old), an old beeswax candle, several gramophone records, a bag of sugar, a pair of black lace gloves, and other trivial odds and ends. Significantly, Manning says the "poltergeist" had "an affinity for electrical appliances." He explains:

> "During the first days of the [poltergeist] phenomenon, an electric ring on our cooker blew out, rendering it cracked and unusable, and causing a fuse in the main fuse box to blow so that the ceramic fuse case was filled with the molten metal of the destroyed fuse. Light bulbs seemed to have a shortened life span, and the cooker adopted a peculiar habit

of turning itself on, unless it was unplugged."[22]

Throughout the second phase of poltergeist activity, Manning was a boarder at a public school, spending time at home during the holiday periods only. In fact, much of this activity took place during his stays at boarding school. Manning shared a dormitory with many other students. On countless occasions at night his heavy steel bunk bed shifted away from the wall of its own accord, as did those belonging to other students. Also at night in the dormitory, it was common for various apports, such as broken glass, pebbles, cutlery, and pieces of wood, to start flying around. A classmate of Manning's named Jon Wills experienced the poltergeist phenomena firsthand. "One night, a pile of dinner plates came down, apparently out of thin air, and shattered on the floor," he said. "Matthew was frightened and I was bloody terrified. It was the sort of experience that, unless you've been through it, you can't begin to comprehend."[23] Understandably, not everyone at the school was accepting of the poltergeist activity, and several times the headmaster was tempted to have Manning sent away.

Automatic writing and drawing

It was while writing an essay in his study at boarding school that Manning discovered he could produce automatic writing. He found that whenever he engaged in automatic writing the poltergeist activity ceased for a while. "[I]t became clear to me that writing was the controlling factor. It appeared that the energy I used for writing had previously been used for causing poltergeist disturbances."[24] Manning also succeeded in channeling the "poltergeist energy" into automatic drawing, producing impressive works of art in the styles of Francisco de Goya, Pablo Picasso, and Albrecht Dürer. Manning possesses little artistic ability (on a conscious level), and the drawings he does automatically are undoubtedly the work of his subconscious mind. Today, as mentioned, he uses his energy for healing purposes only. He believes the poltergeist phenomena he experienced as a child and adolescent "was caused by my own energy. It was nothing to do with spirits."[25]

Scientific findings

In mid-1974, Manning attended a seminar on PK, held at the New Horizons Research Foundation in Toronto, Canada, during which he participated in numerous psychic experiments. In one of the experiments, conducted with Dr. Joel Whitton, Manning was hooked up to an EEG while he attempted to bend a key using PK. As Manning focused on bending the key, his brainwave pattern showed a large increase in low theta and delta waves. Moments later, the key was observed to bend—not while in contact with Manning's hand but while lying on a table in an adjoining room. This "delayed effect," whereby the object responds *after* the psychic has focused on it, is a common feature of PK.

Whitton was astonished by Manning's unique brainwave pattern—which he dubbed "the ramp function" on account of the way it looked—because low delta and theta waves are characteristic of deep sleep, yet Manning was wide awake throughout the experiment. The ramp function, he discovered, originated in Manning's limbic system, the oldest part of the human brain. This finding supports the argument that psi abilities are very ancient indeed, and that our distant ancestors were probably more psychic than us. It should be noted, too, that the limbic system, which is made up of the hypothalamus, the hippocampus, and the amygdala, plays a role in the body's autonomic functions. This applies especially to the hypothalamus, which regulates

body temperature and appetite.

In another experiment, conducted with Nobel Prize winning British physicist Dr. Brian Josephson of the University of Cambridge, Manning used his PK abilities to try to influence a compass. By moving his hands above the compass he was able to make the needle "wave around." As soon as he retracted his hands, the needle stopped moving. However, instead of coming to a gradual stop with a brief back and forth swing, as would be expected, the needle stopped dead. Furthermore, while Manning was projecting his "energy" toward the compass, Josephson reported a peculiar ocular effect whereby he felt as though he was seeing "through a heat haze, such as you get rising from a bonfire."[26] His vision returned to normal the moment Manning had exhausted his energy. As we've seen, the ability to influence a compass needle is not uncommon among electric people and RSPK agents.

Influence on electrical devices

Much about Manning's story agrees with what we've uncovered so far regarding electric people, poltergeistry, RSPK agents, and related topics. The theme that unites these topics is electromagnetism. Before we explore more closely the EM aspects of the Manning case, I should begin by reminding the reader that Manning received at a very young age a severe electric shock. Indeed, he was shocked through his mother just three weeks before she gave birth to him. Of course, it was Dr. Whitton's study that showed that among a group of known psychics all of them had suffered a severe electric shock before the age of 10.

Earlier we identified Wimshurst disorder as one of the primary symptoms of HVS. Did Manning ever suffer from Wimshurst disorder? As a matter of fact he did. He reveals in *The Link* that he went through a period of about a year where "almost any object had the ability to give me a static shock, whether it was metal or another material. I remember receiving electric shocks from books, windows and even whilst holding strawberries."[27]

In both *The Link* and its sequel *In the Minds of Millions* (1977) Manning describes countless instances where he unintentionally influenced electrical devices with his presence alone. One particular example deserves mention here. While a student, Manning made frequent car trips with his father between school and home. On a number of these trips, he says, the engine of the car inexplicably cut out, as though the ignition had suddenly switched off. The problem seemed to be electrical in nature and Manning the cause. He comments: "The remedy we found after some experience of this was for me to get out of the car, after which the engine would start immediately. This has occurred in three different cars and never happened when I was not a passenger."[28] (It would be interesting to know if the engine cut out more often when Manning was journeying from home to school than vice versa.)

Confirmation of Manning's unusual relationship with all things electrical can be found in Colin Wilson's book *Mysteries*. In 1976, some two years prior to the book's publication, Wilson met both Manning and Geller. He says that meeting them "confirmed my feeling that their powers are basically a kind of controlled poltergeist activity," and adds that both men "seem to possess only a limited control over their 'powers.'"[29] He further notes that both "seem to exercise a maleficent influence on electronic equipment."[30] He elaborates:

> "I spent a morning trying to record Matthew, but my cassette recorder—which had worked perfectly up till then, and has worked perfectly ever since—developed a whole

series of baffling faults; tapes that should have contained conversation were blank. With Geller, the tape recorder worked, but objects like electric light bulbs and broken spoons fell out of the air, apparently as much to his surprise as mine."[31]

Uri Geller

Born in Tel Aviv, Israel, in 1946, Geller is undoubtedly the most famous and controversial psychic of modern times. His name is practically synonymous with the term "psychokinesis," by virtue of his famous demonstrations of "spoon bending" in front of large audiences and on television.

During his 1976 meeting with Geller, Wilson asked Geller to explain how he might have gained his psychic abilities. The story that emerged from this question was one that Geller hadn't shared with anyone else, simply because he considered it unimportant. His mother owned a sewing machine. Through a tiny hole in the sewing machine could be seen a bright blue spark. At the age of five, Geller poked his finger through the hole in an attempt to touch the blue spark. The result: he received a severe electric shock and was thrown violently backwards. According to Geller, his abilities manifested not long after this incident.

But wait, isn't Geller a fraud and his so called psychic abilities due to trickery? The consensus among experts on Geller is that he's a genuine psychic but that he sometimes resorts to sleight of hand when unable to produce results on demand. He himself admitted that for a brief period as a stage performer in Israel during the late-1960s he used trickery in one of his acts after his agent convinced him to do so.

PK spoon bending

That ordinary people can, under certain conditions, bend spoons and other metal objects using PK is attested to by countless reputable individuals. During what are known as "PK parties," a concept conceived by the Boeing aeronautical and astronautical engineer Jack Houck, people get together to attempt to bend cutlery in a fun and light-hearted manner. Such parties commonly result in numerous incidents of PK bent cutlery.

In his autobiographical book *Travels*, the author and Harvard medical-school graduate Michael Crichton describes an incident at a spoon bending party whereby he managed to bend a spoon using PK. In his words: "I bent a spoon and I *knew* it wasn't a trick. I looked around the room and saw little children, 8 or 9 years old, bending large metal bars… You just rub the spoon for a while and pretty soon it gets soft, and it bends."[32]

Dean Radin had a similar experience at a spoon-bending party he attended. Using PK, he succeeded in producing a 90-degree bend in the bowl of a large, heavy soup spoon he was holding. Encouraged by an attendee at the party to "bend it all the way," he did precisely that: "To my surprise the bowl felt soft, like putty, so I pinched it with a thumb and forefinger. After the bowl folded over, it stiffened, and within a few seconds it became as hard as steel. The spoon felt cool to the touch, the bend portion was shiny smooth, and there were no signs of metal fatigue."[33]

PK parties demonstrate that everyone possesses psychic abilities but that they normally lie hidden. People like Geller and Manning simply have greater access to these abilities.

Geller in the laboratory

At the height of his fame during the early-1970s, Geller made himself available to scientists who wanted to study his psychic abilities. He participated in two series of experiments at Stanford Research Institute (today SRI International), in Menlo Park, California, under the supervision of laser physicists Russell Targ and Harold Puthoff. The first series of experiments took place over a six-week period in November and December of 1972; the second over a period of eight days in August of 1973. Of these experiments, the ones that yielded the most impressive results concerned ESP and included attempts by Geller to reproduce drawings made by people unknown to him while Geller remained inside a Faraday cage.

One of the target drawings was of a seagull in flight; Geller responded by drawing an almost identical picture of a bird in flight above some trees. More impressive still was Geller's drawing of a bunch of 24 grapes; not only was the target image also of a bunch of grapes, but the grapes added up to precisely 24. These and other impressive results were published in the prestigious scientific journal *Nature* in October 1974, with Targ and Puthoff concluding: "As a result of Geller's success in this experimental period, we consider that he has demonstrated his paranormal ability in a convincing and unambiguous manner."[34]

On two occasions in 1974, Geller participated in PK experiments under the supervision of John Taylor (1931–2012), a particle physicist and Professor of Mathematics at King's College, London. During his first visit to Taylor's lab, on February 2, 1974, Geller broke a teaspoon in two by stroking it gently with his finger as Taylor held the bowl end. Demonstrating that his abilities weren't limited to metal objects, he also broke in two a single crystal of potassium bromide about two centimeters in length (again by stroking it gently). Furthermore, a blue plastic strip was found to have become discolored after Geller held his hands above it. Taylor notes that plastic can become discolored from bending, but insists that Geller did not touch the plastic strip, let alone bend it. Curiously, no effect was observed when Geller stroked with his finger a thin wooden strip.

The next experiment involved a Geiger counter, an instrument used to detect the presence of ionizing radiation. It was thought that, if Geller managed to influence the count rate of the Geiger counter, it would indicate he's able to emit from his body radioactive radiation. Originally, the instrument gave a reading in accordance with normal levels of background radiation (which is around two counts per second). Shortly after Geller started to focus on the Geiger counter, its count rate was heard to increase. Taylor explains what happened next: "[T]he sound suddenly rose to become a wail, one which usually indicates dangerous radioactive material nearby. When Geller stopped concentrating the wail stopped and the apparent danger with it. This wail was repeated twice more, and then when a deflection of one hundred counts per second was achieved, the wail rose almost to a scream."[35]

As an indication that Geller found the feat physically exhausting, Taylor notes that throughout the experiment the Israeli-born psychic displayed extreme concentration and an increase in heart rate and muscular tension. The possibility that Geller influenced the Geiger counter by emitting from his body dangerous levels of ionizing radiation can for obvious reasons be ruled out.

Psi and electromagnetism

In his popular 1975 book *Superminds*, Taylor discusses in detail the experiments he performed with Geller, including the one with the Geiger counter, as well as similar experiments

he performed with a group of children of 16 years old and younger who possessed PK metal-bending and other abilities similar to those of Geller. (The children, known as “mini Gellers,” developed their abilities after seeing Geller perform on TV.) Taylor discards EM radiation from the ionizing portion of the spectrum as a possible explanation for PK, though not EM radiation from the non-ionizing portion of the spectrum.

So, then, can PK and other psychic abilities be explained in terms of non-ionizing EM radiation? First, it’s worth bearing in mind that scientists recognize the existence of four fundamental forces in nature. They are, in order of decreasing strength, the nuclear (or strong) force, the electromagnetic force, the weak force, and the gravitational force. There are a number of reasons—which I haven’t the space to list here—why PK and other psychic abilities cannot be accounted for in terms of the nuclear, weak, and gravitational forces. This leaves us with electromagnetism as our only feasible option.

For a long time parapsychologists suspected that ELF EM waves might have something to do with psi, especially with telepathy, on account of their ability to travel around the Earth with little loss of energy and to penetrate almost anything. The fact that the human body is “tuned to” the Schumann resonance signals of the Earth (which exist in the ELF range) added to the appeal of this theory. Experiments have shown, however, that people can still communicate telepathically (and perform other feats involving psi) when either the “sender” or “target” is placed inside an enclosure that blocks out all forms of EM radiation, including ELF waves. (A Faraday cage is no barrier to ELF waves; however, there are ways to shield them out.)

Throughout the remainder of this chapter, we’ll periodically revisit the question of whether PK and other psychic abilities can be explained in terms of non-ionizing EM radiation.

Further experiments

During his second visit to Taylor’s lab, on June 20, 1974, Geller was asked to influence the needle of a compass without touching it. It was found that, by passing his hands over the compass, he was able to make it rotate by up to 40 degrees. Geller seemed to be able to turn the effect on and off at will. Influencing a compass would be easy to achieve by hiding a magnet in one’s palm. Yet, Taylor assures us, there was no indication that Geller had palmed a magnet. Later, Taylor tried the compass experiment with an anonymous 16-year-old male subject whose proficiency at PK metal bending was as highly developed as Geller’s. “Time and time again,” Taylor says, “the needle moved round and round. Not that this test was always successful, but it was more dependable than metal bending.”[36]

To test this phenomenon further, Taylor constructed a device similar in nature to a PK wheel. This consisted of a transparent cylinder with capped ends. Enclosed within the cylinder was a rod suspended horizontally by a thread. The rod was impervious to draughts and able to rotate with a minimum of external force. Taylor used rods of various materials, including iron, copper, brass, and Perspex. He witnessed varying amounts of rotation in the rods when the subject tried to influence them using PK. He makes an important point: “Fraud was clearly eliminated by the moving of non-magnetic materials, since no direct contact was possible and palmed magnets would have been powerless.”[37]

In PK metal-bending experiments, Taylor made the interesting discovery that pieces of untreated metal, in which the internal stresses had not been removed, were easier for the subject to bend than pieces of treated metal, in which the internal stresses had been removed. The removal of internal stresses from metals is achieved by means of annealing, whereby the metal is

heated to a particular temperature then allowed to cool gradually. This reduces the brittleness of the metal and improves ductility. Put simply, internal stresses weaken a piece of metal; a piece of metal with many internal stresses is weaker than one without. In a spoon or fork, the region of greatest stress is the handle. And, indeed, Taylor found that the spoons and forks bent by his subjects were almost always bent near the handle.

Taylor discovered that the presence or absence of internal stresses was as critical an issue to success for the rotation experiments as for the bending experiments. This applied to when the rod inside the transparent cylinder was made of iron. (Taylor doesn't specify if the same was true of the rods made of other metals.) If the iron rod had been treated (had its stresses removed), the subject was unable to rotate it using PK; if it had not been treated (still had its stresses), the subject was able to rotate it using PK. Taylor explains, "The essential role played by stress in both rotation and bending gives a hint that these two phenomena may involve the same mechanism."[38]

The EM intentionality field

Taylor theorized that PK is achieved by means of an EM "intentionality field" emitted by the subject. This field, he suggested, interacts with the object that the subject wishes to influence. To determine if this field is indeed EM in nature, Taylor checked for the presence of electric and magnetic fields in the rotation experiments, while the subject was using PK to influence the rod. He did not detect a magnetic field, though he did detect an electric field. The electric field was of low frequency and it emanated from a specific area on the subject's arm. Taylor explains:

> "The apparently active area was a disc no more than two or three centimeters across about the same distance above the wrist on the inner arm [of the subject]: significantly, this same arm was the most effective one in metal-bending. At times the subject would complain that sensations of static electricity were building up over this arm; to relieve these he would put his hand in water, sometimes experiencing an electric shock when he did."[39]

Taylor's finding of an electric field from the wrist area of the subject takes on great importance when viewed in relation to the case of Angélique Cottin. As you'll recall, Dr. Sanchon, one of the physicians who studied Angélique, believed her abilities were due to a "gaseous current" or "fluid" that emanated from the front part of her body, particularly around the *wrist and elbow region* of her left arm. When Dr. Sanchon put his hand near this region, he felt a cool breeze "similar to that made by lips." Could this sensation have been due to an electric field emitted by Angélique's body? Quite possibly. In general, there is an impressive degree of similarity between the details reported by Dr. Sanchon concerning Angélique and the details reported by Taylor concerning his 16-year-old subject. The fact that the latter experienced difficulty with static electricity (Wimshurst disorder) is also noteworthy.

Taylor notes that the subject suffered from eczema, including on the arm from which the electric field was emitted. He says the eczema on this arm became particularly severe during the rotation experiments, especially on the "apparently active area" above the wrist. Taylor continues: "The amount of irritation caused by the eczema appeared to be closely correlated with the power of rotation the subject had over the suspended rod; when his arm had soothing ointment on it his powers were absent. One might speculate that this irritation was caused by the emitted radiation interacting with the surface of the skin."[40] Taylor adds: "The hypothesis is that

metal bending and rotation are both caused by low frequency electric fields emitted by various parts of the body, these fields being amplified by stresses in the materials themselves."[41]

The electromagnetic aura

Taylor's hypothesis hinges on the recognition that EM fields emanate from the human body, which together make up what he calls the "electromagnetic aura." The most noticeable component of the EM aura, or bodily EM field, is that which exists in the form of infrared radiation (heat). We can't perceive the heat emitted by the body because our eyes don't allow us access to the infrared portion of the EM spectrum. As we discussed earlier, however, plenty of animals can perceive infrared radiation, pit vipers being one example.

It's a well-known fact that the human body is a highly sophisticated electrochemical machine. Constituting a second component of the bodily EM field is the ever-changing electrical activity of both our nervous system and muscles. First let's consider the nervous system, the body's electrical wiring, which consists of nervous tissue. Nervous tissue is composed of nerve cells, or neurons. The neurons in the human brain number an estimated 85 billion to 200 billion.

A typical neuron consists of a cell body containing a nucleus and two or more long fibers. There are two different types of nerve fibers: those that conduct impulses toward the cell body, called dendrites, and those that conduct impulses away from the cell body, called axons. What we refer to as nerves are bundles of fibers (axons and dendrites) held together by connective tissue.

It's a common misconception that neurons provide a pathway for electrons the way the wires in your home do. In actual fact, the electrical signals carried by neurons—called nerve impulses—involve the movement of ions (electrically charged atoms) as opposed to electrons. Neuronal activity, then, is electrochemical in nature. Furthermore, the neurons in your body, though densely packed together, never actually touch; between the axon of one neuron and the dendrite of the next neuron is a tiny gap called the synapse. When a nerve impulse reaches the synapse, a neurotransmitter is released; this excites the neighboring neuron and so allows the impulse to continue its journey.

Every time an electrical impulse travels down a neuron, that neuron is surrounded by a tiny electric field. The electrical impulses generated by the neurons of the brain and their associated electric fields fluctuate rhythmically in distinct patterns. It is these patterns of electrical activity that are detected and recorded by an electroencephalograph (EEG), via electrodes attached to the scalp.

In addition to the electrical activity of our nervous system, there is the electrical activity of our muscles to consider. Like neurons, muscle cells generate electrical impulses and hence electric fields. Muscles at rest produce little electrical activity, whereas muscles at work are highly electrically active. The heart, which is basically a large muscle, contracts in a rhythmic fashion to pump blood around the body. Its unceasing electrical activity can be recorded using an electrocardiograph (ECG).

In summary, the bodily EM field is a product of (1) the infrared radiation emitted by the body; and (2) the electrical activity of both our nervous system and muscles. Admittedly, the EM field of the body is very weak; however, parts of it, such as that which surrounds the head, have been reliably measured using an extremely sensitive detector of magnetic fields called a superconducting quantum interference device (SQUID). Thanks to this technology, it's been confirmed beyond all doubt that the human body is surrounded by an EM field.

EM fields caused by muscular activity?

Could the EM field of the body play a role in PK, as suggested by Taylor? While the detection of a low frequency electric field from the wrist area of his 16-year-old subject is an interesting finding, how this field produced rotation in the rods (and bending in pieces of metal) remains unanswered. Electric fields could, on the other hand, account for some of the strange EM effects that occur in the presence of electric people and RSPK agents, perhaps including those that involve streetlamps.

Taylor suggests that the aforementioned electric field was a result of muscular activity. It's true that the muscles of the body become electrically active when at work and in so doing emit electric fields. Clearly, though, the electric field is difficult to explain in terms of muscular activity alone. For, as we know, the EM energy emitted by the body is extremely weak and can only be picked up using highly sensitive equipment. Also, isn't it rather odd that the electric field emanated exclusively from a tiny area on the subject's wrist?

It's noteworthy that the subject had eczema. This, in Taylor's view, was "caused by the emitted radiation interacting with the surface of the skin."[42] However, there is another, more logical explanation for the eczema. As we discussed earlier, eczema—or dermatitis as it's commonly known—is a type of inflammation of the skin that occurs as one of the symptoms of an allergic reaction. It's also exhibited by those who suffer from EHS. Was the subject an EHS sufferer then? To explore this possibility in detail, it's necessary we turn our attention to the work of Dr. Cyril Smith.

Before we do so, I should mention that Taylor abandoned his attempts to explain PK in terms of electromagnetism, including distancing himself from the field of parapsychology, when it became apparent that his theory had hit a brick wall. As many scientists before him had discovered, psi phenomena is difficult to reconcile with conventional physics. This greatly troubled Taylor, and he went from being a supporter of psi to a skeptic of anything remotely paranormal. In a book he wrote as a follow up to *Superminds*, called *Science and the Supernatural*, he states that the evidence for PK metal bending is "suggestive but certainly not watertight."[43]

Professor Marcello Truzzi, who at one point belonged to the Committee for the Scientific Investigation of Claims of the Paranormal (CSICOP), commented: "Taylor's case is a strange one. He began by being quite convinced and pursued a new theoretical explanation. When he found his theory would not work, he started questioning everything that he affirmed earlier. Many of us think he got badly burnt by his doubting colleagues and largely wrote this negative book [*Science and the Supernatural*] to salvage his reputation."[44]

Dr. Cyril Smith: EHS pioneer

Dr. Cyril Smith, who worked at Salford University in the Department of Electronic and Electrical Engineering until his retirement in 1989, is an expert on the adverse health effects of non-ionizing EM fields as well as a pioneer researcher on EHS. Working in cooperation with Dr. Jean Monro of Breakspear Medical Group, Ltd., UK, Smith has successfully treated countless EHS patients. In his 1989 book *Electromagnetic Man* (written in collaboration with Simon Best), Smith provides an outline of the methods he developed to treat EHS patients. These methods, which come under the domain of "energy medicine," will be addressed in a moment.

Smith defines the term allergy as "the failure of a regulatory system" and he says it's not

uncommon for severely allergic patients to have acquired allergic responses to tens, sometimes hundreds, of substances of an environmental, nutritional, or chemical nature.[45] Because, in Smith's view, an intolerance is equivalent to an allergy, throughout this section I'll avoid the term intolerance and use the term allergy only.

According to Smith, the acquisition of multiple allergies is due to a kind of transference effect. This effect operates as follows: if while reacting strongly to a substance to which you're allergic—for example, pollen—you come into contact with a substance to which you've never been allergic—for example, paint thinner—your body will then identify the latter as something to which you're allergic. This means that next time you encounter paint thinner you'll experience an allergic reaction (while remaining allergic to pollen). The same phenomenon can occur in the case of EM fields. For example, if while reacting allergically to paint thinner you're exposed to a powerful source of EM radiation—say, RF radiation emitted by a smart meter—you will then become allergic to the latter. Since EHS is frequency specific, you'll only react allergically to the particular frequency (or frequencies) of RF radiation emitted by the smart meter.

Provocation-neutralization

By far the most effective alternative method for treating patients who are allergic to certain foods or chemicals is provocation-neutralization or low-dose immunotherapy. The method works as follows: A small dose of "antigen vaccine" (the substance to which the patient is allergic) is injected under the first few layers of the patient's skin. The result will be a bump or wheal at the injection site—an indication that the antigen vaccine has provoked an allergic reaction in the patient. The procedure is repeated using successively lower concentrations of the antigen vaccine. Eventually, a concentration of antigen vaccine will be identified to which the patient no longer reacts allergically. This is called the neutralization dose, because it is the dose at which the patient's symptoms disappear.

The patient must take the antigen vaccine at regular intervals in order to keep their allergy symptoms at bay. Depending on the patient and the allergy being treated, the neutralization dose can be so weak as to reach homeopathic levels of dilution, whereby no molecules of the antigen remain. Its effectiveness seems to be due to the ability of water to retain a "memory" of substances previously dissolved in it to arbitrary dilution—the much talked about "memory of water." Amazingly, it has been found that, rather than take the antigen vaccine by means of injection (or drops under the tongue), all the patient has to do to achieve the same result is hold in their hand a glass phial containing the antigen vaccine.

The method developed and utilized by Smith to treat EHS patients is based on the same principles as provocation-neutralization. Provocation is achieved not by injecting the patient with successively lower dilutions of antigen vaccine but by exposing them to a spectrum of EM frequencies generated by an assortment of electronic oscillators (including an RF oscillator). By gradually tuning the devices—from, say, 0.1 Hz to 1 MHz—the operator is able to identify which particular frequencies (or range of frequencies) trigger an allergic response in the patient, and, more importantly, which particular frequencies do not trigger an allergic response in the patient. The latter are the patient's neutralizing frequencies—the frequencies at which their symptoms disappear. Smith explains: "The patient usually finds this experience of having their symptoms turned on and off by an external agency quite comforting, particularly if they have been told by many doctors for many years that 'The illness is all in your mind'…"[46]

We now come to the second part of Smith's EHS treatment method. With the oscillator set to

one of the patient's neutralizing frequencies, a glass phial filled with saline (salt) solution is exposed for a period of four minutes to a magnetic field produced in a coil connected to the oscillator, "imprinting" the water inside with that particular frequency. The procedure is repeated for each of the patient's neutralizing frequencies, using each time a new glass phial. Again, to keep their allergy symptoms at bay, all the patient has to do is hold one of the glass phials in their hand. Apparently, the phials remain effective for one to two months. They can even be sent to the patient when they need them, as long as they're protected against breakage and thoroughly wrapped in aluminum foil. The aluminum foil is a necessary precaution against external magnetic fields, which can "overwrite" the frequency imprinted on the water and so render it ineffective.

Smith states that when testing patients using his method the critical factor is not the strength of the signal emitted by the oscillator but rather the frequency at which it is set. Again, this shows that EHS sufferers respond (react allergically) to specific frequencies of EM radiation, not to EM radiation in general. Smith also states that the room in which the patient is tested needs to be screened against external EM fields, although he warns that when patients are reacting allergically "they often emit electrical signals themselves; if these are reflected back to them by the very metal which is providing the screening, their allergic reactions may become more severe."[47] The best way to counter this problem, Smith discovered, is to place in the room with the patient plastic buckets filled with salt water; the salt water absorbs the electrical signals emitted by the patient.

"Rather like electric fish"

Smith's claim that EHS patients emit EM signals while reacting allergically is of obvious relevance to the subjects discussed in this chapter. He describes this phenomenon by saying that EHS patients "seem to be able to 'zap' their environment electromagnetically and sense any resonances within it, rather like electric fish."[48] Significantly, Smith says the EM signals can be strong enough to cause electrical devices in the vicinity of the patient to malfunction. He offers a couple of examples: "One patient had a robotic system in a factory completely malfunction each time he stood near it. Another has had the electronic ignition system on successive new cars fail as soon as an allergic reaction was triggered by fumes from a diesel truck in front."[49]

Smith goes on to state that the EM signals emitted by EHS patients will register on a plastic-cased tape recorder, provided the signals lie within the audio frequency range (20 Hz to 20,000 Hz). "If the subject is reacting strongly enough, there will be sufficient interference passing through the plastic case to be picked up by the amplifier circuits," Smith explains. "A wide variety of signals may be obtained on replay and these vary not only from patient to patient but differ on different occasions with the same patient."[50] Smith describes one type of signal as a series of clicks and adds that a similar type of electrical waveform is observed with certain species of electric fish.

■■■

In relation to the above, one is reminded of the many accounts in the paranormal literature of tape recorders inexplicably malfunctioning in the presence of psychics and "alien abductees," or when brought to "haunted" locations. A perfect example is the experience described by Colin Wilson regarding his meeting with Matthew Manning, whereby the tapes used in his tape recorder kept coming out blank. Can we conclude, then, that Manning suffered from EHS in adolescence, and that the electrical disturbances he caused during that period in his life were due

to his emitting EM signals from his body while reacting allergically? Can we conclude the same with respect to Taylor's 16-year-old PK metal-bending subject? Was the low frequency electric field he emitted, along with the patches of dermatitis on his body, the result of his being in an allergic state?

To provide answers to these questions would require extensive scientific research and hence is a job for the biologists, physicists, and parapsychologists, not for a humble author such as myself. However, I think it's safe to conclude that psychic ability goes hand in hand with both EHS and HVS. I would even go so far as to say that having EHS or HVS is a prerequisite to being psychic.

The theories of Albert Budden

The UFO phenomenon is vast and complex and its EM roots run deep and in multiple different directions. By far the world's leading researcher on the EM aspects of the UFO phenomenon is Albert Budden, author of *UFOs Psychic Close Encounters* and *Electric UFOs*. Budden's perspective on the UFO phenomenon, called the electrostaging hypothesis (ESH), hinges on the recognition that those who consider themselves alien abductees commonly suffer from EHS accompanied by multiple allergies and intolerances.

Budden argues that strong EM fields generated by both artificial and natural sources (for example, geological faulting in the case of the latter) can induce in people, particularly if they suffer from EHS, vivid hallucinatory experiences featuring alien beings. Although these experiences are interpreted by the individual as episodes of alien abduction, they are in fact a form of symbolic communication on the part of the individual's subconscious mind, telling the individual's conscious mind that their health is under threat from exposure to EM fields. "[M]y approach states that it is the activity of the human unconscious *in combination* with a variety of artificial and natural energies that produces staged realities identified as the CE [close encounter] experience [author's own emphasis]."[51] Budden explains further:

> "Such high-strangeness encounters occur in locations where the environmental electromagnetic fields are elevated…. The encounters can take the form of vivid hallucinatory visions induced by the effects of electric fields on the brain and are symptoms of [EHS]…. My own research has shown that individuals who experience these bizarre high-strangeness encounters have usually had a major electrical event in their formative years which acts as an initiation for [EHS] in later life. This event may have been in proximity to a lightning strike, ball lightning, geological light phenomena ('earth lights'), major electrocution, and so on."[52]

The "God helmet"

Budden's conclusions support and complement my own. In addition to accepting EHS as an intrinsic component of the alien abduction phenomenon, he makes mention in his books to the paranormal and mystical experience inducing effects of magnetic field stimulation of the temporal lobes of the brain, as demonstrated by Michael Persinger's famous "God helmet" experiments. The God helmet, a modified snowmobile helmet with solenoids placed over the temporal lobes, subjects that region of the brain to weak but complex magnetic fields, in some cases causing the wearer to experience a sensed presence, an out of body experience (OBE), and various other forms of weirdness. Some even report the feeling of being in the presence of God

—hence the name of the device. Persinger claims that approximately 80 percent of those who try the God helmet have an odd experience, usually of a sensed presence.

Persinger points out that the degree of sensitivity of the temporal lobes to magnetic field stimulation varies from person to person. Meaning that those with highly sensitive temporal lobes are prone to mystical and paranormal experiences; whereas those at the opposite end of the spectrum are not. This would explain why the device affects some people and not others. Persinger's research with the God helmet suggests that a significant percentage of experiences deemed mystical and paranormal are probably due to EM fields affecting the temporal lobes (and other vulnerable areas) of the brain. Living in an EM hotspot and having highly sensitive temporal lobes would no doubt act to facilitate such experiences.

It's interesting to speculate whether those who have had what Budden calls a "major electrical event" develop as a consequence highly sensitive temporal lobes, and hence slip into altered states of consciousness easily when exposed to EM fields. On a related topic, there's evidence that people with EHS, while reacting allergically, can undergo vivid hallucinations, experience total loss of consciousness, as well as enter trance states during which they become "zombie-like" and mute. Michael Shallis argues that the state of consciousness experienced by allergically reacting EHS sufferers is one of heightened psychic ability. He explains, "When [EHS] patients are suffering from their symptoms they display a remarkable gift for clairvoyance and extra-sensory perception. Their lowered thresholds somehow makes them open to another level of susceptibility and they can reach out into other people's thoughts and feelings."[53]

A brief look at ball lightning

To me it seems perfectly reasonable of Budden to identify ball lightning as an initiator of EHS along with conventional lightning and other powerful sources of electromagnetism. The reader will recall that Sarah S.—several of whose symptoms match those of EHS—claims to have seen ball lightning on two separate occasions. (It's amazing enough to see ball lightning once.)

Once relegated to the realm of myth and imagination, ball lightning has gradually gained acceptance among scientists as a real—albeit rare, fleeting, and elusive—aerial phenomenon. Although it's not unheard of for ball lightning to be seen during perfect weather, it's generally associated with thunderstorms, typically occurring near the ground after an incident of cloud-to-ground lightning.

A family panics as ball lightning enters their home (from The Aerial World *by G. Hartwig, 1886). Image courtesy of the National Oceanic and Atmospheric Administration.*

Ranging in size from one-half inch to many meters in diameter, ball lightning can occur in a variety of different colors, the most common being red, orange, and yellow. It's luminous enough to be seen clearly in daylight; rarely is it dazzling. Most instances of ball lightning last only 10 seconds or less; instances of more than a minute are rare. Often the object is accompanied by a hissing sound and distinct odor resembling ozone, burning sulfur, or nitric oxide. In most cases, the object will be seen to move about and then vanish, decaying either explosively or silently. "After the ball has decayed, it is sometimes reported that a mist or residue remains," Martin Uman explains. "Occasionally a ball lightning has been observed to break up into two or more smaller balls."[54]

Countless theories have been advanced to explain the existence of ball lightning. One such theory views the phenomenon as magnetic field–induced hallucinations caused by being in close proximity to a lightning strike. However, without overlooking the possibility that there may be many different types of ball lightning, each with its own mechanism of production, the phenomenon can best be explained as a form of high-density plasma. While some of the attempts by physicists to create ball lightning in the laboratory have yielded intriguing results, so far none of them have come close to producing anything as spectacular and awe-inspiring as that which nature produces herself.

Proving that ball lightning is physically real is the fact that numerous cases exist where the object has left behind traces of physical damage, such as by burning or melting objects in the vicinity, or by injuring or killing people and animals. There are cases where ball lightning has left perfectly circular holes in panes of glass, in some cases by melting a hole straight through the glass; in other cases by removing a circular piece of glass as though by means of a glass cutter. It's possible, too, for ball lightning to pass straight through a pane of glass—or wall, ceiling, or floor—without the least amount of hindrance. It can even enter a room by squeezing through the keyhole of the door, adjusting its shape in order to fit. Just as mysterious, ball lightning has a tendency to enter homes via the chimney.

Putting aside for the moment the more spectacular characteristics of the phenomenon, let's take a look at a typical incident of ball lightning, as reported by E. Matts of England on November 10, 1940:

> "I was working at the far end of my garden; the weather was normal, no rain, [and] no signs of thunder. Suddenly I seemed to be in the centre of intense blackness and looking down [I] observed at my feet a ball about 2 ft. across. It was of a pale blue-green colour and seemed made of a mass of writhing strings of light, about 1/4 in. in diameter. It remained there for about three seconds and then rose, away from me, just missing a poplar tree about 3 ft. away. It cleared the house by about 20 ft. and landed at the rear of the Weavers Arms on the Bell Green road, a distance of about 1/4 mile. There was a loud explosion and much damage was done to the public house."[55]

Sometimes ball lightning materializes inside homes, airplanes, and other types of enclosures, suggesting as a possible mechanism of production some form of electrostatic induction. The following case took place in 1960 onboard a KC-97 U.S. Air Force tanker en route to Nevada:

> "As I was concentrating on the instruments on the panel (no outside visual references were visible) a ball of yellow-white color approximately 18" in diameter emerged through the windshield center panels and passed at a rate about that of a fast run between my left seat and the co-pilot's right seat, down the cabin passageway past the Navigator and Engineer. I had been struck by lightning two times through the years in previous flights and recall waiting for the explosion of the ball of light! I was unable to turn around and watch the progress of the ball as it proceeded to the rear of the aircraft, as I was expecting the explosion with a full load of JP-4 fuel aboard and concentrated on flying the aircraft. After approximately 3 seconds of amazingly quiet reaction by the 4 crew members in the flight compartment, the Boom operator sitting in the rear of the aircraft called on the interphone in an excited voice describing a ball of fire that came rolling through the aft cargo compartment abeam the wings, then danced out over the right wing and rolling off into the night and clouds! No noise accompanied the arrival or departure of the phenomenon."[56]

By far the strangest ball lightning reports are those where the object displays apparent intelligence. According to Paul Snigier (1943–2008) in his book *Ball Lightning: Paradox of Physics*, "Although many balls act dumb, others exhibit puzzling behavior that seems almost supernatural and quasi-intelligent. Some balls chase people across fields and up or down stairs. A few circle people, spiraling up from the knee level to the head and then dart out the nearest window or up a chimney, then explode."[57] Snigier, who wrote *Ball Lightning* under the pseudonym Paul Sagan, worked as an electrical engineer for Raytheon and Texas Instruments, later becoming editor of the computer magazines *Mini Microsystems* and *Digital Design*.

Featured in Paul Devereux's book *Earth Lights Revelation* is a clear and credible report of seemingly intelligent ball lightning. The report was sent to Devereux by a University of Illinois industrial design professor named William Becker. Becker's ball lightning encounter took place in the summer of 1958 while on a canoeing trip with five high school friends in a region north of Grand Marias, Minnesota. At one point during the trip, the weather turned bad, forcing Becker and his friends to seek shelter in an abandoned cabin. Becker and one of his friends made themselves comfortable in the back room of the cabin; the others occupied the remaining rooms.

Before long the rain outside had turned into a downpour and the sky had darkened considerably with the onset of evening. Becker opened the window a crack to emit some of the heat that had accumulated in the room throughout the day. A moment later, he and his friend saw "what looked like a flashlight moving around outside the opened window."[58] At first Becker assumed he was witnessing a prank perpetrated by a member of the group. He picks up the story:

> "To our complete amazement, the 'flashlight' illumination began to squeeze through the open, one-inch crack above the window sill. As we watched, a 'bubble' of light emerged from the space in the open window and slowly floated into the room. The lightball I estimated to be just larger than a basketball. It hung in the air a moment and seemed to be making a lot of rapid short movements which added up to overall 'smooth' motions.
>
> "The ball had a bright outer perimeter of yellow-white light with an inner core of darker orange light. As it moved from the window on my right to just in front of me, I saw what looked like 'worms' or short 'strings' of light writhing at its center. It made no sound, but slowly descended towards the floor where an old black and white, Indian-style rug still lay inside the door. Inexplicably, the lightball moved down just over the rug, and as it continued across the room from my right to my left, it 'traced' or followed the dark patterns in the rug on its course. It then slowly proceeded towards the end of the room where it angled away and shrunk in size as if finding an escape hole in the corner kick boards. In a moment, it was gone."[59]

Before Becker and his friend had time to discuss the astonishing incident, they heard from behind the wall of the room "a sharp piercing report, like a loud firecracker."[60] The following day they found, at the location where the explosion had occurred, some damage in the form of a broken drain pipe connection. It is Becker's hypothesis that "lightning must have interacted with some of the many copper deposits in the area to produce the ball."[61]

"If not a rational skeptic, your author could suspect that fireballs might be a transient life form with some form of 'alien' intelligence," Snigier adds. "Perhaps DNA-based life is not the only form of life on Earth. If so, then are fireballs non-carbon–based life forms?"[62]

The notion of ball lightning as non-carbon based life forms is not as outrageous as it sounds. In fact, a number of erudite UFO researchers view both ball lightning and their "cousins," earth lights, as "plasma-based" life forms indigenous to Earth—about which I'll have more to say on in a moment.

I wish to conclude our discussion on ball lightning with the following quote by William R. Corliss (1926–2011), a respected physicist and author of books on scientific anomalies: "Perhaps the intense electrical forces occurring during some thunderstorms somehow distort our space-time continuum and provide a fleeting glimpse into some unknown cosmos. Ball lightning is strange enough to stimulate such wild thoughts."[63]

Earth Lights and Earthquake Lights

As their name suggests, earthquake lights are unusual luminous phenomena that appear in the atmosphere in association with earthquakes. They can manifest either prior to, during, or following earthquake activity. In most cases they precede earthquake activity, and hence can act as a warning that an earthquake is about to strike in the area. They vary in form from bluish flames, to floating, glowing orbs, to shimmering, multi-colored clouds. The majority of lights

reported have an aurora-like appearance.

Despite sharing a number of similarities both with ball lightning and earthquake lights, earth lights belong in a class of their own. They appear in locations all over the world and are called different names and attributed to different causes depending on the cultural context. In the United States they're known as "spook lights"; in Australia, the "min min lights"; while in Ireland and other parts of Europe they're usually associated with the faerie.

Earth lights tend to haunt specific locales, places that are geologically "special" in one or more respect, such as owing to the presence of a fault line, a body of water—a lake, dam, river, or waterfall—or to significant deposits of minerals. Such places include Marfa, Texas; in the valley of Hessdalen, Norway; the Boulia region of western Queensland, Australia; and the Pennines of England.

In addition to being seen around Boulia, which lies within the region known as Channel Country, the min min lights have been spotted east of Brisbane (also in Queensland), within the Nullarbor Plain, and in the Kimberley region of Western Australia. The lights are said to be named after a former staging post between Winton and Boulia, named the Min Min Hotel, which met its demise in 1918 as a result of fire. A sign on the way into Boulia describes the phenomenon as an "unsolved modern mystery" and adds that the light (or lights) "at times follows travellers for long distances—it has been approached but never identified."[64]

In 1995, earth lights expert Paul Devereux and his colleague Erling Strand travelled to a remote location in the Kimberley region of Western Australia, in response to reports of strange light phenomena, including "balls of light," by people who'd worked there. By questioning local aborigines and others, the pair learned that the local min min lights were a regular phenomenon throughout the 1970s and 1980s, but that sightings of the lights had dropped since that period. They further learned that the aborigines were pleased by the reduction in sightings because they "feared and disliked the lights, as they [the lights] were associated with unpleasant physical side-effects and 'poltergeist'-type events."[65]

During the expedition, Devereux and Strand observed at night "distant moving lights, variously blue-white or soft, golden-yellow in appearance."[66] Yet by far the most impressive observation of min min light activity occurred as the expedition was drawing to a close. Devereux describes the sighting: "Two bright, yellow-white lights, appearing separately, shone out against the slopes of uninhabited hills about 7 miles (11 km) from the field monitoring station. In the course of a few minutes they traversed a downward path and then disappeared."[67] Coinciding precisely with the appearance of the lights was an "extremely anomalous change in the geomagnetic field some 800 times greater than normal."[68] The anomaly was registered by a magnetometer probe inserted into the ground a distance of around 200 meters from the team's observation point. Devereux and his colleagues have recorded similar geomagnetic anomalies in association with the appearance of earth lights.

Foo fighters

It's generally agreed that the modern UFO era began with Kenneth Arnold's famous sighting of nine shiny objects flying in a chain-like formation near Mount Rainier, Washington, on June 24, 1947. Arnold, a businessman and experienced aviator, came to the conclusion that the strange objects he saw that day from the cockpit of his private plane—and on subsequent occasions, for he actually experienced additional UFO sightings—were not extraterrestrial spacecraft but rather

"groups and masses of living organisms that are as much a part of our atmosphere and space as the life we find in the depths of our oceans."[69]

Arnold's view of UFOs as living organisms is known as the "space animal" theory. Perhaps its best-known proponent is Trevor James Constable, a New Zealand-born aviation historian and former Radio Electronics Officer in the U.S Merchant Marine, who argues in his classic tome *The Cosmic Pulse of Life* that UFOs "…are amoebalike life-forms existing in the plasma state. They are not solid, liquid, or gas. Rather, they exist in the fourth state of matter—plasma—as living heat-substance at the upper border of physical nature."[70] Constable refers to these alleged atmospheric life forms as "critters" and says they "have their main existence in a density that is invisible to human beings of normal vision."[71] He makes the remarkable claim of having photographed using infrared film numerous critters in their natural, invisible state.

Rather than saying that the modern UFO era began in 1947 with Arnold's famous sighting, it would be more accurate to say that the phenomenon entered public consciousness on that date. The modern UFO era actually dates back to World War II, coinciding with the perfection and widespread use of radar. "The persistent (as opposed to occasional) UFO phenomenon, in just about all its varieties, arrived during World War II, not in 1947," the UFO authority Jerome Clarke explains.[72] Chief among these "varieties" were the baffling "foo fighters," or "kraut balls," red, gold, green, silver, or white balls of light, varying from a few inches to a few feet in diameter, that pursued and toyed with military aircraft, evading all attempts to be shot down or outmaneuvered. The objects, which either appeared individually, in pairs, or in groups, reportedly exhibited basic signs of intelligence and behaved in a manner that could best be described as playful. The term "foo fighter," said to have been coined by a pilot and operations officer named Charlie Horne, was derived from a catchphrase featured in the Smokey Stover comic strip that stated "where there's foo, there's fire."[73]

The foo fighters were especially active toward the end of the War and in the skies over Germany. Furthermore, the vast majority of reports feature lights seen at night rather than during the day. The Allies suspected that foo fighters might be some kind of Nazi secret weapon (hence also calling them "kraut balls") and consequently took such reports very seriously. However, there are two main reasons why this theory fails to hold water. First, the lights were never hostile but merely inquisitive and playful; and second, similar lights were encountered by German and Japanese pilots, who were also baffled by them. That the lights were capable of travelling at very high speed, could simply vanish and reappear in the blink of an eye, could perform outrageously complex maneuvers, and were not detectable by radar all argue heavily against the Nazi secret weapon theory.

A large number of foo fighter sightings were reported by pilots of the 415th Night Fighter Squadron (NFS) of the Army Air Forces (the unit to which Charlie Horne belonged) while operating out of Dijon and Ochey, France, between November 1944 and April 1945. During this period, the 415th made nightly patrols over the German-occupied Rhine River Valley. The patrols involved shooting down German night fighters and bombing targets on the ground, all done with the assistance of both ground and air-based radar systems.

The unit's Commanding Officer, Harold F. Augspurger, was far from ignorant of the foo fighter sightings reported by his men, yet had never seen one of the mysterious lights himself. That all changed, however, on the night of December 28, 1944, while conducting an intruder mission at low altitude over Germany, accompanied by radar operator Lt. Austin Petry.

That night, the sky was cloudless and moonless and the weather bitterly cold. As Augspurger

piloted his Bristol Beaufighter named “Nightmare,” while scanning the ground below for targets of interest, Petry remained focused on the radar screen in front of him in anticipation of the appearance of enemy bogies. After 90 minutes of uneventful flying, it was time to turn around and head back to base. What happened next was extremely surprising. The moment Augspurger peered out the cockpit, having glanced down at his controls for a split second or two, he noticed they were no longer alone. Flying alongside them, “out off to the starboard, right off the wing,” was a strange white light.[74]

Petry was just as puzzled as Augspurger as to the identity of the light, which they could tell wasn’t a shooting star, a rocket, a jet, a flare, or any other known phenomena. The light was round, solid, and emitted no exhaust or flame (such as would be expected in the case of a machine). It continued to pace them, seemingly keeping them under surveillance, its behavior intelligent and precise. Because the sky was extremely dark, the men were unable to accurately determine either the distance of the light with respect to Nightmare or the size of the light. They concluded that it was either a “real big light real far away, or a small light close in on us.”[75]

The light refused to register on radar, even though Nightmare’s radar system was known to be working perfectly fine. Eager to get a closer look at the light, Augspurger opened up the throttle and turned his aircraft toward it. As they began to close in on their target, Petry continued his attempts to bring it up on radar, but still had no success. About 30 seconds later, the light “just took off and went straight up,” climbing “at a tremendous speed” for a couple of thousand feet before vanishing entirely from view.[76] The sighting lasted a total of four to five minutes. The pair reported their experience to Captain Fred B. Ringwald, the unit’s intelligence officer, immediately upon returning to base.

Augspurger and Petry’s experience is very much a typical foo fighter encounter, which explains its inclusion here. The foo fighter mystery is worth examining not only because it demonstrates a correlation between the sudden, widespread use of radar and the emergence of the modern UFO phenomenon, but also because it argues against the popular interpretation of UFOs as ships from other planets, known as the extraterrestrial hypothesis (ETH). To suggest that these ghostly balls of light, some no bigger than tennis balls, were craft of extraterrestrial origin is to overstep the bounds of common sense. The theory of foo fighters as secret Nazi technology is equally without merit. Unfortunately, there is a strong desire on the part of UFO researchers and enthusiasts to perceive UFO events in terms of nuts-and-bolts extraterrestrial technology or secret military technology, to the complete exclusion of natural explanations.

Many aspects of the UFO phenomenon become rather less puzzling when examined in relation to ball lightning, earth lights, and other plasmatic manifestations of earthly origin. In my opinion, many of the objects encountered by pilots during World War II and called foo fighters were either some form of ball lightning (perhaps one that exists only at high altitude) or a very close cousin of ball lightning. It’s important to note that ball lightning can appear not only inside aircraft but also external to aircraft. The latter types of sightings match closely in detail those under the label of foo fighters. Consider the following ball lightning report from a 1973 paper by the physicist R. C. Jennison:

> “A further important observation was of a 20 cm ball which appeared at a height of about 50 cm over the trailing edge of the mainplane of an aircraft in flight. It moved parallel to the line of the mainplane at a speed of about 1 m s^{-1} [1 meter per second] before being cast off the end and was not blown off in spite of the considerable air speed.”[77]

■■■

Sometimes reported in association with ball lightning and its cousins are various EM field and electrostatic field effects. Many cases exist where automobile or plane engines have malfunctioned when closely approached by a UFO. In some such cases, the UFO witness is left with burns to their body and other symptoms typical of radiation exposure, including nausea, vomiting, fever, and fatigue. As for episodes of alien abduction, these too can be tackled from an EM perspective, given that strong EM fields have the potential to induce hallucinatory states.

The EM approach revisited

Budden subscribes to the theory that both PK and RSPK can be explained in terms of electromagnetism. In his view, the phenomenon whereby EHS sufferers emit EM signals from their bodies while reacting allergically is responsible for the RSPK effects that sometimes occur in the homes of self-proclaimed alien abductees. Also in Budden's view, the phenomenon provides an explanation for cases where people have been struck by lightning multiple times. He comments, "Such unlucky people, it seems, emit a coherent beam of electromagnetic energy as an allergic reaction on encountering the atmospheric charge of a thunderstorm, and offer an easier route to earth than the electromagnetically undifferentiated air of the atmosphere."[78] Budden adds that the first strike experienced by the victim is the one that leaves them with EHS; after that, they more or less attract lightning as a result of reacting allergically to thunderstorms. Budden's theory is not without merit. It perhaps explains why Roy Sullivan described himself as "allergic to lightning."

In his books, Budden makes the mistake of attempting to explain every aspect of the UFO phenomenon, as well as almost every subject within the sphere of the paranormal, in terms of electromagnetism. Yet as we well know at this point in our investigation—and as John Taylor realized to his great disappointment—the EM approach falls short in certain respects. This is especially true of PK. Since many instances of PK defy the laws of electromagnetism, it figures that PK does not have an EM basis. It seems that the energy behind PK phenomena is not electromagnetism but that it behaves in a manner very similar to electromagnetism.

A fifth force?

As discussed, scientists recognize the existence of four fundamental forces in nature, one of these forces being electromagnetism. However, physicists have long speculated on the possibility of a fifth force in nature, one that, if found to exist, would extend the Standard Model of particle physics.

Unparticle physics

Each of the four fundamental forces is mediated by the exchange of a particular kind of particle. In the case of electromagnetism, the particle in question is the photon. In the case of the supposed fifth force, the particle in question is thought to be a mysterious entity called an unparticle. The unparticle, which was first proposed in 2007 by Harvard physicist Howard Georgi, possesses an unusual property called scale invariance whereby its mass varies depending on the way we measure it. An article in *New Scientist* states that due to the property of scale invariance "unparticle exchange would not drop off as quickly as electromagnetism with distance —potentially giving rise to measureable long-range effects."[79]

The supposed fifth force, whether linked to the unparticle or some other type of particle, carries what is known as long-range spin-spin interaction. The standard form of spin-spin interaction, called short-range, is a property of electromagnetism. A magnet stuck to the door of a fridge is an example of short-range spin-spin interaction. The magnet stays held in place because the electrons in the magnet and those in the metal door of the fridge are all spinning around in the same direction. However, since magnetic force diminishes as per the inverse square law, the magnet would fall to the ground due to insufficient attraction if separated from the surface of the fridge by only a very small distance. If, on the other hand, the magnet was held in place via long-range spin-spin interaction, it's attraction to the door of the fridge would persist if separated by a much larger distance. This is why in the *New Scientist* article the hypothetical fifth force is described as a "version of magnetism that does not weaken as quickly with distance."[80]

Could the supposed fifth force have something to do with psi? It's very difficult to say because the existence of a fifth force remains inconclusive; so far, attempts to detect such a force have come up empty-handed. A recent experiment, undertaken by Professor Larry Hunter and colleagues at Amherst College and The University of Texas at Austin, demonstrated that a fifth force, if it exists, would be extremely weak—as much as a million times weaker than the gravitational force. The very low strength of the supposed fifth force argues against the notion of a connection between it and psi. On the other hand, its ability to cause long-range effects argues in favor of a psi connection.

Orgone energy

Could the supposed fifth force be the "cosmic life energy" discovered by Wilhelm Reich (1897–1957) between 1936 and 1940, called orgone? Reich, a Viennese psychiatrist who immigrated to the United States in 1939, defined orgone as an energy present in all living things, including in the atmosphere, the soil, and the vacuum of outer space, and claimed he'd verified its existence scientifically. According to James DeMeo, Ph.D., founder of the Orgone Biophysical Research Laboratory (OBRL), orgone is "the *medium* through which electromagnetic disturbances are transmitted, much in the manner of the older concept of *aether*, though it is not itself electromagnetic in nature [his emphasis]."[81]

Some of the properties of orgone identified by Reich include: (1) it is mass free and thus devoid of inertia or weight; (2) it is present everywhere and fills all space; (3) it flows from areas of low concentration to areas of high concentration (unlike electricity, which flows from higher to lower potential); (4) it penetrates all matter, but at different rates of speed; (5) it has an affinity for water; and (6) organic materials attract and absorb it while non-organic materials, particularly metals, repel and reflect it.

Reich's famous orgone energy accumulator is a box-shaped enclosure lined with sheet metal, its walls packed with alternate layers of organic and inorganic materials. The purpose of the device is to capture orgone energy in the atmosphere. They can be built large enough to accommodate a human being and were utilized by Reich as a form of treatment for people suffering from cancer and other maladies. (He believed not that the device cured cancer but that it accelerated tissue growth, repair, and wound healing.) It was the lease of orgone accumulators for therapeutic purposes that brought Reich in conflict with the U.S. Food and Drug Administration (FDA) and led to his subsequent death on November 3, 1957, in a federal prison in Lewisburg, Pennsylvania.

Whether Reich actually discovered and verified scientifically a new form of energy—perhaps

the equivalent of Franz Anton Mesmer's *animal magnetism* or the *qi* or *chi* ("air," "breath," or "life force") of Chinese medicine and philosophy—or whether he only imagined he did is heavily debated to this day. Although a handful of dedicated orgonomists (orgonomy is the study of orgone energy) in the United States and elsewhere claim to have duplicated Reich's experiments and consider him a misunderstood genius, the mainstream perception of Reich is of a deluded crackpot who practiced pseudoscience.

Reich argued that current electricity and static electricity are fundamentally different from each other, such that the latter is actually orgone. He therefore believed that an electroscope—an instrument used to detect the presence of static electricity—was in truth an "orgonoscope." Reich's unique perspective on static electricity is worth mentioning here in view of its involvement in cases of electric people. Perhaps the energy responsible for PK is actually static electricity—not as it's presently understood but rather as it will be understood when science catches up with Reich's discoveries. It would be naive to assume that scientists know everything there is to know about electricity (static or current).

■■■

In summary, it would appear that some form of energy other than the ones currently acknowledged by mainstream science is behind psi phenomena. Whether one chooses to call it orgone, chi, psychic energy, or the fifth force is perhaps beside the point. The author and Institute of Noetic Sciences (IONS) member John White, in an article titled "What is Psychic Energy?," summarizes the characteristics of this hypothetical energy by paraphrasing the ideas of the American physicist Laurence Beynam: "[T]here is an energy in living organisms that is weak and unpredictable, but it can be refracted, polarized, focused and combined with other energies. It sometimes has effects similar to magnetism, electricity, heat and luminous radiation, but it is none of these."[82]

Psi and quantum mechanics

Today, many parapsychologists, including Dean Radin, are convinced that psi phenomena can best be explained within the framework of quantum mechanics. Quantum mechanics is a branch of physics that deals with the behavior of matter and light on the atomic and subatomic scale. Whereas the laws of classical mechanics govern the behavior of objects that exist in the macro-world, such as cars, basketballs, and people, the laws of quantum mechanics govern the behavior of atoms, electrons, protons, neutrons, photons, and other tiny particles of the micro-world.

Since the macro-world is the one we inhabit, each of us has some understanding of how the laws of classical mechanics operate. For example, we know that if we throw two balls into the air, one green and one red, in different directions to each other, where the green ball lands will in no way affect where the red ball lands, and vice versa, for the simple reason that the balls are separate entities and haven't come into contact with each other. Conversely, in the micro-world—the realm of quantum mechanics—such weird and baffling phenomena as entanglement exist. If we imagine the balls are quantum entangled, where the green ball lands *will* affect where the red ball lands, because the two balls *are* linked, albeit not in the physical sense.

Attempts have been made by parapsychologists to explain telepathy along the lines of quantum entanglement. If we suppose that quantum entanglement occurs within the brain, it's perfectly reasonable to further suppose that individuals can exchange information telepathically because the brain of every person is quantum entangled with the brain of every other person. The

natural response to such a theory, from one well-versed in quantum mechanics, is that quantum effects require extremely cold conditions (near absolute zero) and a tightly controlled environment, while the brain, by comparison, is a warm, wet, messy environment and hence cannot sustain such effects. Add to this the fact that the laws of quantum mechanics generally apply to tiny things, rather than to macro-world objects like the brain. Yale University physicist Steven Girvin explains, "It's a general fact that the larger an object is, the more classical it is in its behavior, and the more difficult it is to see quantum mechanical effects."[83] In other words, it's not that quantum effects don't apply to objects in the macro-world—they can, only the effects are elusive and hard to detect.

So what about the possibility of quantum effects in the brain? Scientists have amassed a great deal of evidence suggesting not only that effects like entanglement occur in biological systems but that such effects are pervasive in the natural world. Earlier we saw that quantum entanglement is thought to play a role in avian magnetoception, as per the radical-pair-based mechanism. There's compelling evidence, too, that plants exploit quantum effects to achieve photosynthesis, enabling them to capture the energy of the Sun with near perfect efficiency. That the human brain functions in the manner of a quantum computer, such that consciousness arises from quantum effects in the brain, is a theory championed by the theoretical physicist Roger Penrose and the anesthesiologist Stuart Hameroff. (Quantum computers, which have already been developed to a rudimentary level, take advantage of quantum mechanical effects to perform super-fast computations.)

If the brain indeed operates on a quantum mechanical level, it would go a long way toward providing an explanation for telepathy and other psi abilities. Also, given the evidence discussed earlier for magnetoception in human beings using a radical-pair-based mechanism, it's possible our ability to sense the Earth's magnetic field is tied up with our ability to perform psi, since both appear to rely on quantum entanglement. It's a fact that extremely talented psychics are also very talented dowsers—a skill that probably involves sensing the Earth's magnetic field. For example, Uri Geller is such an accomplished dowser he's been paid large sums of money by oil and mining corporations to help locate deposits of gold, diamond, and other precious substances.

Conclusion

The day prior to writing this section, an event occurred that helped put matters into perspective as well as answer the question of what this book is about. Early on the morning of March 12, at 1:30 a.m., the entire city of Darwin, where I currently reside, was thrown into darkness as a result of a power outage. Everything in the city that ran on electricity, including all the streetlamps and traffic lights, stopped working. When I emerged from bed around five hours later, I foolishly drank from a bottle of milk in the refrigerator, despite being aware of the risks involved. A couple of hours later, I began to come down with the usual symptoms of mild food poisoning.

By the time power was restored to the city, at around 1 p.m., I was still feeling the effects of the food poisoning. I didn't fully recover until that evening. The experience reminded me how fortunate we are to have access to electricity and the many services it provides—in particular, refrigeration. It's easy to forget that not everyone in the world has access to electricity. Yet there are two sides to every situation. You see, I slept better on the night of March 12 than I had in a very long time. While I admit it was hotter than usual as a result of the ceiling fan in my room not working, the night was quiet, peaceful, and beautifully dark. However, I suspect that the

main factor responsible for my sleeping soundly that night was the significant drop in background levels of artificial EM radiation, giving my body a much-needed break from the stimulatory effects of such radiation.

The experience of the power outage planted in my mind an intriguing idea. I propose that, every year for precisely one day, towns and cities around the world should go without electricity. Call it an annual voluntary blackout. Ice boxes could be used for refrigeration and gas for cooking and heating. Electricity produced by generators would enable essential services like hospitals to continue running. And so forth.

Of course, there's no way annual voluntary blackouts would ever become a reality, though if they did we'd learn a lot from the experience. For one thing, we'd realize we've become overly dependent on electricity, both as a society and as individuals. It would even help us prepare for a widespread blackout that might occur in the future, such as from a powerful solar storm. Just as important, it would teach us that not having access to electricity has its benefits as well as its disadvantages. Some of the other ways the experience might affect us include: large numbers of people would find that they suddenly feel healthier and enjoy a perfect night's sleep; unable to watch television, children would be forced to play outdoors or read books; authors such as myself would realize that typewriters are not so inferior to computers after all; and reports of paranormal experiences would diminish….

Chapter Notes

Introduction

1. Cyril W. Smith and Simon Best, *Electromagnetic Man*, 128–129.
2. Matthew Manning, *The Link*, 10.

Chapter 1

1. "Magnesium Supplements and Radiation Remedies: An Interview with Carolyn Dean, MD, ND," *nutritionalmagnesium.org*, 2010, *www.nutritionalmagnesium.org/magnesium-supplements-radiation-remedies/* (accessed April 4, 2014).
2. Amanda Onion, "How Sea Turtles Find Their Way," *ABCNews.com*, October 12, 2012, *http://abcnews.go.com/Technology/story?id=98240* (accessed April 3, 2012).
3. Ibid.
4. Johnsen and Lohmann, "Magnetoreception in Animals."
5. Ibid.
6. Ibid.
7. Eder, et al., "Magnetic Characterization of Isolated Candidate Vertebrate Magnetoreceptor Cells."
8. Ed Yong, "New Technique Identifies Magnetic Cells in Animals by Watching Them Spin," *nationalgeographic.com*, July 9, 2012, *http://blogs.discovermagazine.com/notrocketscience/2012/07/09/new-technique-identifies-magnetic-cells-in-animals-by-watching-them-spin/#.UzzD6lfE* (accessed April 4, 2014).
9. Emily Sohn, "Animals Navigate with Magnetic Cells," *discoverynews.com*, July 9, 2012, *http://news.discovery.com/animals/endangered-species/animal-navigation-magnetism-120709.htm* (accessed April 4, 2014).
10. Burda et al., "Extremely Low-Frequency Electromagnetic Fields Disrupt Magnetic Alignment of Ruminants."
11. Ed Yong, "Power Lines Disrupt the Magnetic Alignment of Cows and Deer," *nationalgeographic.com*, March 16, 2009, *http://scienceblogs.com/notrocketscience/2009/03/16/power-lines-disrupt-the-magnetic-alignment-of-cows-and-deer/* (accessed April 4, 2014).
12. Sachs, *Ayurvedic Beauty Care*, 95.
13. Kirschvink, et al., "Magnetite Biomineralization in the Human Brain."
14. Sandra Blakeslee, "Magnetic Crystals, Guides for Animals, Found in Humans." *nytimes.com*, May 12, 1992, *www.nytimes.com/1992/05/12/science/magnetic-crystals-guides-for-animals-found-in-humans.html* (accessed April 4, 2014).
15. Nancy McVicar, "Power Lines and Brain Tumors: Assessing the Risk," *sun-sentinel.com*, January 3, 1993, *http://articles.sun-sentinel.com/1993-01-03/features/9301010513_1_power-lines-electromagnetic-fields-brain-tumors* (accessed April 4, 2014).

16. Levitt, *Electromagnetic Fields*, 152.
17. Baker, "A Sense of Magnetism."
18. Ibid.
19. Ibid.
20. Ibid.
21. Ibid.
22. Ibid.
23. Ibid.
24. Ed Yong, "Humans Have a Magnetic Sensor in Our Eyes, But Can We Detect Magnetic Fields?" *discoverymagazine.com*, June 21, 2001, *http://blogs.discovermagazine.com/notrocketscience/2011/06/21/humans-have-a-magnetic-sensor-in-our-eyes-but-can-we-see-magnetic-fields/#.UzzGP1fE6es* (accessed April 4, 2014).
25. Westby and Partridge, "Human Homing: Still No Evidence Despite Geomagnetic Controls."
26. Ibid.
27. Ed Yong, "Humans Have a Magnetic Sensor in Our Eyes, But Can We Detect Magnetic Fields?"

Chapter 2

1. Ahmad et al., "Magnetic Intensity Affects Cryptochrome-Dependent Responses in Arabidopsis Thaliana."
2. Foley, et al., "Human Cryptochrome Exhibits Light-Dependent Magnetosensitivity."
3. Ibid.
4. Ed Yong, "Humans Have a Magnetic Sensor in Our Eyes, But Can We Detect Magnetic Fields?," *Discover Magazine*, June 21, 2011, *http://blogs.discovermagazine.com/notrocketscience/2011/06/21/humans-have-a-magnetic-sensor-in-our-eyes-but-can-we-see-magnetic-fields/#.UlSHclOLCK4* (accessed October 9, 2013).
5. Ibid.
6. Jason Palmer, "Human Eye Protein Senses Earth's Magnetism," *BBC News*, June 21, 2011, *www.bbc.co.uk/news/science-environment-13809144* (accessed October 9, 2013).
7. Jeanna Bryne, "Humans May Have 'Magnetic' Sixth Sense," June 21, 2011, *www.livescience.com/14694-humans-sixth-sense-magnetic-fields.html* (accessed October 9, 2011).
8. "Nervous System, Human," *Encyclopedia Britannica*, Chicago, 2011.
9. "Pineal Gland," *Encyclopedia Britannica*, Chicago, 2011.
10. "Melatonin," *American Cancer Society*, *www.cancer.org/treatment/treatmentsandsideeffects/complementaryandalternativemedicine/p* (accessed October 9, 2013).
11. Ibid.
12. "Melatonin," *Encyclopedia Britannica*, Chicago, 2011.
13. Cayce and Auken, *Toward a Deeper Meditation*, 209.
14. "Chakra," *Encyclopedia Britannica*, Chicago, 2011.
15. Clow, *Liquid Light of Sex*, 133.
16. Sting, *Broken Music*, 11.

17. Strassman, *DMT: The Spirit Molecule*, 316.
18. Rick Strassman, "DMT: The Spirit Molecule," *www.rickstrassman.com/index.php?option=com_content&view=article&id=54&Itemid=54* (accessed October 9, 2013).
19. Steve Twedt, "Clockwise: West German Researcher Studies Sleep-Wake Cycle," *The Pittsburgh Press*, June 16, 1986, *http://news.google.com/newspapers?nid=1144&dat=19860616&id=s3QdAAAAIBAJ&sjid=u2IEAAAAIBAJ&pg=5096,42542* (accessed October 10, 2013).
20. "Schumann Resonance Animation," *NASA*, *http://svs.gsfc.nasa.gov/vis/a010000/a010800/a010891/* (accessed October 10, 2013).
21. "The First Solar Flare," *Australian Government Bureau of Meteorology*, *www.ips.gov.au/Educational/2/4/4* (accessed October 10, 2013).
22. Ibid.
23. Richard A. Lovett, "Solar Flare: What If Biggest Known Sun Storm Hit Today?," *National Geographic*, *http://news.nationalgeographic.com.au/news/2012/03/120308-solar-flare-storm-sun-space-weather-science-aurora/* (accessed October 10, 2013).
24. Michael Hanlon, "Why We Face Grave Danger From Space," *The Telegraph*, August 13, 2013, *www.telegraph.co.uk/science/space/10239218/Why-we-face-grave-danger-from-space.html* (accessed October 10, 2013).
25. "Heliobiology," *The Great Soviet Encyclopedia*, *http://encyclopedia2.thefreedictionary.com/Heliobiology* (accessed October 10, 2013).
26. Berk, et al., "Do Ambient Electromagnetic Fields Affect Behaviour?"
27. Ibid.
28. Catherine Brahic, "Does the Earth's Magnetic Field Cause Suicides?," *New Scientist*, April 24, 2008, *http://www.newscientist.com/article/dn13769-does-the-earths-magnetic-field-cause-suicides.html#.UleTc1OLBkM* (accessed October 10, 2013).
29. J.B. Burch, et al., "Geomagnetic Disturbances Are Associated With Reduced Nocturnal Excretion of A Melatonin Metabolite In Humans."
30. Wilson, "Evidence for an Effect of ELF Electromagnetic Fields on Human Pineal Gland Function."
31. Ibid.

Chapter 3

1. Wes Hosking, "Smart Meter Shock Forces Family Out," *Herald Sun*, November 1, 2011, *www.heraldsun.com.au/ipad/smart-meter-shock-forces-family-out/story-fn6bfm6w-1226181905576* (accessed December 1, 2013).
2. Ibid.
3. Julianne Walker, "Smart Meters 'Make Us Sick' Claim," April 12, 2012, *Gippsland Times*, *www.gippslandtimes.com.au/story/216204/smart-meters-make-us-sick-claim/* (accessed December 1, 2013).
4. "Electromagnetic Fields (EMF)," *World Health Organization*, *www.who.int/peh-emf/en/* (accessed December 1, 2013).
5. Ibid.
6. Ibid.
7. Ibid.
8. "Non-ionizing Radiation, Part 1: Static and Extremely Low-Frequency Electric and Magnetic

Fields," *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*, Vol. 80, 2002.
9. "IARC Publishes Rationale for RF as Possible Human Carcinogen," *Microwave News*, April 19, 2013, *http://microwavenews.com/short-takes-archive/iarc-publishes-rf-cancer-review* (accessed April 14, 2014).
10. Smith and Best, *Electromagnetic Man*, 212.
11. Ibid, 212.
12. Becker and Selden, *The Body Electric*, 316.
13. Lilienfeld, et al., "Foreign Service Health Status Study," 246.
14. *Electromagnetic Man*, 214.
15. Ibid., 214.
16. Ibid., 215.
17. Bise, "Low Power Radio Frequency and Microwave Effects on Human Electroencephalogram and Behavior."
18. Ibid.
19. "Stress," *Encyclopedia Britannica*, Chicago, 2011.
20. Becker, *Cross Currents*, 195.
21. Ibid, 196.
22. "Microwaves Promote Cancer," *Microwave News*.
23. Barton Reppert, "Microwaves Suspected As Source of Cancer," *Schenectady Gazette*, August 17, 1984, *http://news.google.com/newspapers?nid=1917&dat=19840817&id=iUJGAAAAIBAJ&sjid=3-gMAAAAIBAJ&pg=1240,310823* (accessed December 1, 2013).
24. Guy, et al., "Long-Term, Low-Level Microwave Irradiation of Rats."
25. Ibid.
26. Ibid.
27. *Cross Currents*, 195.
28. Ibid., 196.
29. Caitlin Esch, "Are Smart Meters Dangerous, Too?," *East Bay Express*, July 21, 2010, *http://www.eastbayexpress.com/oakland/are-smartmeters-dangerous-too/Content?oid=1939740&showFullText=true* (accessed December 1, 2013).
30. Ibid.
31. "Former Smart Meter Installer Suffers From Electro Hypersensitivity (EHS)," October 10, 2012, *http://stopsmartmeters.com.au/2012/10/10/former-smart-meter-installer-suffers-from-electro-hypersensitivity-ehs/* (accessed December 2, 2013).
32. Ibid.
33. Ibid.
34. "Electromagnetic Fields and Public Health: Electromagnetic Hypersensitivity," December, 2005, *www.who.int/peh-emf/publications/facts/fs296/en/* (accessed December 2, 2013).
35. Ibid.
36. Ibid.
37. Ibid.
38. Levallois et al., "Study of Self-Reported Hypersensitivity to Electromagnetic Fields in California," *Environmental Health Perspectives* 110, August, 2002, 619–623.

39. Noor Javed, “One Woman’s Battle with Electromagnetic Hypersensitivity,” *Toronto Star*, Jun 15, 2013, *http://www.thestar.com/news/insight/2013/06/15/cellphone_towers_one_womans_struggle_w* (accessed December 2, 2013).
40. Veronica Ciandre, “My Story,” March 20, 2010, *http://sowegrounded.yolasite.com/my-story.php* (accessed December 2, 2013).
41. Michele Mandel, “Woman Feels the Waves: Claims Exposure to Wireless Radiation Affects Her Health,” *Toronto Sun*, August 17, 2010, *www.torontosun.com/news/columnists/michele_mandel/2010/08/17/15054141.html* (accessed December 2, 2013).
42. Javed, “One Woman’s Battle with Electromagnetic Hypersensitivity.”
43. Ibid.
44. Ibid.
45. Landgrebe, et al., “Association Of Tinnitus And Electromagnetic Hypersensitivity: Hints For A Shared Pathophysiology?”
46. Frey, “Human Auditory System Response to Modulated Electromagnetic Energy.”
47. Ibid.
48. *Cross Currents*, 252.
49. Tom Blackwell, “Wi-Fi Safety: The Debate Over Wireless Technology Continues,” *National Post*, 11 August, 2012, http://news.nationalpost.com/2012/08/11/sick-of-wi-fi-the-debate-over-its-safety-is-not-going-away/ (accessed December 1, 2012).
50. André Fauteux, “Electromagnetic Intolerance Elucidated,” January 17, 2012, *www.emfacts.com/2012/01/electromagnetic-intolerance-elucidated*/ (accessed December 2, 2013).
51. Ibid.
52. Ibid.
53. Johansson, “Disturbance Of The Immune System By Electromagnetic Fields.”
54. Ibid.
55. Ibid.
56. Ibid.
57. Ibid.
58. Rubin, et al., “Electromagnetic Hypersensitivity.”
59. Ibid.
60. Fauteux, “Electromagnetic Intolerance Elucidated.”
61. McCarty, et al., “Electromagnetic Hypersensitivity.”
62. Ibid.

Chapter 4

1. Hank Burchard, “Lightning Strikes 4 Times,” *Lakeland Ledger*, May 2, 1972, *http://news.google.com/newspapers?nid=1347&dat=19720502&id=OScVAAAAIBAJ&sjid=afoDAAAAIBAJ&pg=7465,354926* (accessed April 4, 2014).
2. Ibid.
3. Friedman, *Out of the Blue*, 4.

4. Ibid., 4.
5. Ibid., 5.
6. Kruszelnicki, *Curious and Curiouser*, 174.
7. "Surprising Jupiter: Busy Galileo Spacecraft Showed Jovian System is Full of Surprises," *nasa.gov*, November 30, 2007, *www.nasa.gov/vision/universe/solarsystem/galileo_end.html* (accessed April 4, 2014).
8. Smyth, *The Writings of Benjamin Franklin*, 32.
9. Uman, *All About Lightning*, 2.
10. Ibid., 2.
11. Stenhoff, *Ball Lightning*, 75.
12. Ibid., 75.
13. Uman, *All About Lightning*, 2.
14. Ibid., 152.
15. Michael McQuilken, "A Hair-Raising Experience on Moro Rock," *california-hiking.com*, January 6, 2013, *www.socialpositive.com/c/stories/A-Hair-Raising-Experience-on-Moro-Rock-133301* (accessed April 4, 2014).
16. Ibid.
17. Ibid.
18. Ibid.
19. Michael McQuilken. Email to Louis Proud, May 5, 2014.
20. "The Lightning Desperation Position," *noaa.gov*, August 31, 2010, *http://www.crh.noaa.gov/pub/ltg/CLRP_feetWHY.php* (accessed April 4, 2014).

Chapter 5

1. *The Box*: motion picture, written and directed by Richard Kelly, Warner Brothers Pictures, 2009.
2. Ibid.
3. Ibid.
4. Ibid.
5. Ibid.
6. Ibid.
7. Ibid.
8. Cooper and Price, "Electrical and Lightning Injuries."
9. Mary Ann Cooper, "Medical Aspects of Lightning," *www.uic.edu/labs/lightninginjury/overview.htm* (accessed December 31, 2013).
10. Friedman, *Out of the Blue*, 244.
11. Struckbylightning.org, Inc., 2005–2013, *http://www.struckbylightning.org/mission.cfm* (accessed December 31, 2013).
12. Michael Utley, *http://struckbylightning.org/forms/utley~noaa.pdf* (accessed December 31, 2013).
13. Ibid.
14. Michael Utley, "My Personal Bolt of Lightning," *The New York Times*, August 27, 2001, *http://www.nytimes.com/2001/08/27/opinion/my-personal-bolt-of-lightning.html* (accessed December 31, 2013).

15. Barbara J. Paulsen, “Survivors: A Bolt From Beyond Can Change Your Life Permanently,” *Discover*, August 2002, *http://discovermagazine.com/2002/aug/featlightning#.UsIs27SZ-es* (accessed December 31, 2013).
16. Friedman, *Out of the Blue*, 221.
17. Ibid., 223.
18. Evan Williams, “It’s Lightning Season,” *Fort Myers Florida Weekly*, July 16–22, 2008, *http://fortmyers.floridaweekly.com/news/2008-07-16/top_news/001.html* (accessed December 31, 2013).
19. Lightning Strike & Electric Shock Survivors International, Inc., 2013, *http://www.lightning-strike.org/DesktopDefault.aspx?tabid=60* (accessed December 31, 2013).
20. Friedman, *Out of the Blue*, 225.
21. Zachary Turpin, “An Interview with Jerry LeDoux, Lightning Strike Survivor,” Book of Odds, Inc., 2013, *http://bookofodds.com/content/view/print/653692* (accessed January 4, 2013).
22. Ibid.
23. Ibid.
24. Joshua Foer, “Don’t Stand By Me: Surviving a Lightning Strike,” June 6, 2005, *www.slate.com/articles/news_and_politics/dispatches/2005/06/dont_stand_by_me.html* (accessed December 31, 2013).
25. Turpin, “An Interview with Jerry LeDoux, Lightning Strike Survivor.”
26. Ibid.
27. Foer, “Don’t Stand By Me: Surviving a Lightning Strike.”
28. Turpin, “An Interview with Jerry LeDoux, Lightning Strike Survivor.”
29. Ibid.
30. Michelle Hedbloom, “Lightning Strikes Victim Four Times,” *Spartanburg Herald Journal*, September 1, 2005, *http://news.google.com/newspapers?nid=1876&dat=20050901&id=7n0jAAAAIBAJ&sjid=z9AEAAAAIBAJ&pg=6854,111796* (accessed December 31, 2013).
31. Ibid.
32. Arden Moore, “Many Survive Lightning Jolts But Suffer From Aftereffects,” *Sun Sentinel*, October 12, 1993, *http://articles.sun-sentinel.com/1993-10-12/lifestyle/9310080800_1_international-lightning-strike-steve-marshburn-world-records* (accessed December 31, 2013).
33. Ibid.
34. Friedman, *Out of the Blue*, 9–10.
35. Ibid, 10.
36. Ibid., 243–244.
37. Ibid.
38. Ibid., 243.
39. Zachary Turpin, “An Interview with Jerry LeDoux, Lightning Strike Survivor.”
40. Friedman, *Out of the Blue*, 12.
41. Ibid, 15–16.
42. Ibid, 243.
43. Lauren Stalford, “Lightning Strikes OU Employee Not Twice, But Six Times,” *The*

Oklahoma Daily, April 20, 2009, *http://oudaily.com/news/2009/apr/20/lightning-strikes-ou-employee-not-twice-six-times*/ (accessed December 31, 2013).
44. Reshma Kirpalani, "Father and Son Both Victims of Lightning, 48 Years Apart," July 15, 2011, *http://abcnews.go.com/Technology/father-son-die-lightning-strikes-48-years/story?id=14080318* (accessed December 31, 2013).
45. Ibid., 183.
46. Ibid., 183.
47. Megan Varner, "We Are All Survivors of Some Sort," *Index-Journal*, May 10, 2006, *www.zoominfo.com/p/Harold-Deal/851209311* (accessed December 31, 2013).
48. Friedman, *Out of the Blue*, 184.
49. Ibid, 184.
50. Friedman, *Out of the Blue*, 184.
51. Ibid, 184.
52. Ibid, 184.
53. Dayna Harpster, "Florida Lightning Survivors Share Stories," *USA Today*, July 1, 2009, *http://usatoday30.usatoday.com/weather/2009-07-01-lee_lightning_survivors_N.htm* (accessed 31 December, 2013).
54. Mireya Navarro, "When Lightning Strikes, Lives Are Changed," September 1, 1998, *The New York Times*, *www.nytimes.com/1998/09/01/us/when-lightning-strikes-lives-are-changed.html?pagewanted=2* (accessed December 31, 2013).
55. Ibid., 201.
56. Ibid., 202.
57. Ibid., 219.
58. Ibid., 219.
59. Ibid., 219.
60. Chris Rodell, "Unlucky Strikes," *The Independent*, 7 November, 1999, *www.independent.co.uk/arts-entertainment/unlucky-strikes-1124177.html* (accessed December 31, 2013).
61. Dayna Harpster, "Florida Lightning Survivors Share Stories."
62. Ibid.
63. Friedman, *Out of the Blue*, 186.
64. Ibid, 186.
65. "The Will to Live," *Prevention*, November, 2011, *www.prevention.com/health/healthy-living/stories-medical-miracles?page=3* (accessed December 31, 2013).
66. Ibid.
67. Friedman, *Out of the Blue*, 187.
68. Ibid, 187.
69. "Survivor Story: Missy: High Price for Pizza? Supernatural Side effect?," *NOAA*, *www.lightningsafety.noaa.gov/survivors/story_missy.htm* (accessed December 31, 2013).
70. Ibid.
71. "Survivor Story: Thais: Open Window Results in Strike," *NOAA*, *www.lightningsafety.noaa.gov/survivors/story_thais.htm* (accessed December 31, 2013).
72. Ibid.
73. Ibid.

74. Wes Smith, “Seeing Things: Downstate Psychic Greta Alexander Is Known Worldwide As A Woman of Visions,” *Chicago Tribune*, June 9, 1991, *http://articles.chicagotribune.com/1991-06-09/features/9102210281_1_psychicabilities-unsolved-murder-case* (accessed January 1, 2014).
75. “Psychic Key to Cops Finding Remains of Slain Woman,” *The Evening News*, Nov 16, 1983, *http://news.google.com/newspapers?nid=1982&dat=19831116&id=2tBeAAAAIBAJ&sjid=t20NAAAAIBAJ&pg=2498,1826524* (accessed January 1, 2014).
76. Kalweit, *Shamans, Healers, and Medicine Men*, 46.
77. Neihardt, *Black Elk Speaks*, 149.
78. Cooper, et al., *Wilderness Medicine*.
79. Christopher J. Andrews. Email to Louis Proud, December 8, 2013.
80. Ibid.
81. Mary Ann Cooper. Email to Louis Proud, December 10, 2013.
82. Ibid, December 7, 2013.
83. Ibid, December 7, 2013.
84. Ibid, December 8, 2013.
85. Christopher J. Andrews. Email to Louis Proud, December 8, 2013.
86. Ibid, December 8, 2013.
87. Christopher J. Andrews. Email to Louis Proud, December 8, 2013.
88. Mary Ann Cooper. Email to Louis Proud, December 9, 2013.
89. Ibid, December 9, 2013.
90. Eltiti, et al., “Development and Evaluation of the Electromagnetic Hypersensitivity Questionnaire.”

Chapter 6

1. “Poisoned Convicts Become ‘Electrified’!”
2. Ibid.
3. Ibid.
4. Ibid.
5. Ibid.
6. David Wilkes, “Meet Mavis, The Super-Charged Grandmother Whose Touch BLOWS UP Kettles,” February 22, 2008, *http://www.dailymail.co.uk/news/article-517487/Meet-Mavis-super-charged-grandmother-touch-BLOWS-UP-kettles.html* (accessed February 3, 2014).
7. Ibid.
8. Ibid.
9. Bill Spicer, “Power-Full Curse,” *New Straits Times*, June 8, 1985, http://news.google.com/newspapers?nid=1309&dat=19850608&id=2udLAAAAIBAJ&sjid=yY0DAAAAIBAJ&pg=6826,202773 (accessed February 3, 2014).
10. Ibid.
11. Ibid.
12. Ibid.
13. Ibid.

14. Ibid.
15. Kate R. Email to Louis Proud, May 23, 2013.
16. Shallis, *The Electric Connection*, 19.
17. Ibid., 29.
18. Ibid., 25.
19. Ibid., 27.
20. Ibid., 27.
21. Ibid., 33.
22. Ibid., 23.
23. "A Human Electric Battery."
24. Ibid.
25. "The Electrical Girl."
26. Ibid.
27. Ibid.
28. Ibid.
29. Ibid.
30. Ibid.
31. Evans, *The SLI Effect*, 4.
32. "About us," *ASSAP*, *www.assap.ac.uk/newsite/htmlfiles/About.html* (accessed February 4, 2014).
33. Evans, *SLIDERS*, 7.
34. Evans, *The SLI Effect*, 4.
35. Ibid, 7.
36. Evans, *SLIDERS*, 12.
37. Ibid, 12.
38. Ibid.
39. Ibid.
40. Ibid.
41. Ibid.
42. David P. Email to Louis Proud, May 23, 2013.
43. Ibid.
44. Ibid, 95.
45. Ibid, 95.
46. Ibid, 13–14.
47. Ibid, 13–14.
48. Ibid, 13–14.
49. Evans, *The SLI Effect*, 33.
50. Ibid., 33.
51. David Derbyshire, "'Electricity Woman with Amazing Powers' Causes Lights to Flicker When She Gets Stressed," *Mail Online*, 2 February, 2008.
52. Evans, *The SLI Effect*, 18.
53. Evans, *SLIDERS*, 105.
54. David P. Email to Louis Proud, May 23, 2013.

55. Corby F. Email to Louis Proud, May 24, 2013.
56. Ibid.
57. Evans, *SLIDERS*, 83.
58. Allen Spraggett, "Pursuing the Elusive Poltergeist," *The Pittsburgh Press*, January 2, 1974, *http://news.google.com/newspapers?id=oBsfAAAAIBAJ&sjid=E5YEAAAAIBAJ&pg=5846,1740188&dq=rosenheim+poltergeist&* (accessed February 4, 2014).
59. Ibid.
60. Broughton, *Parapsychology*, 235–236.
61. "The Investigation of a 'Pseudo-Poltergeist' Case in the West Midlands: Report by George Gregg and Frank Smith," *Parasearch*, 2003, *www.zen118739.zen.co.uk/parasearch/westmids.html* (accessed February 4, 2014).
62. Ibid.
63. Ibid.

Chapter 7

1. Clarkson, *The Poltergeist Phenomenon*, 62.
2. Ibid., 74.
3. Ibid., 64.
4. Ibid., 66.
5. Ibid., 62.
6. Ibid., 66.
7. Ibid., 70.
8. Ibid., 70.
9. Ibid., 72.
10. Ibid., 69.
11. Roll, et al., "Case Report: A Prototypical Experience Of 'Poltergeist' Activity, Conspicuous Quantitative Electroencephalographic Patterns, and Sloreta Profiles—Suggestions For Intervention," *Neurocase*, Vol. 18, Issue 6, 2012, 1–10.
12. Clarkson, *The Poltergeist Phenomenon*, 68.
13. Ibid., 69.
14. Ibid., 74.
15. Ibid., 74.
16. Ibid., 73.
17. Ibid., 73.
18. Ibid., 88.
19. Ibid., 88.
20. Manning, *The Link*, 25.
21. Ibid., 25.
22. Ibid., 37.
23. Clarkson, *The Poltergeist Phenomenon*, 215.
24. Manning, *The Link*, 66.
25. Clarkson, *The Poltergeist Phenomenon*, 215.
26. Manning, *In the Minds of Millions*, 7.

27. Manning, *The Link*, 68.
28. Ibid., 99.
29. Wilson, *Mysteries*, 444.
30. Ibid., 444.
31. Ibid., 444.
32. Crichton, *Travels*, 320.
33. Radin, *Supernormal*, 220.
34. Targ and Puthoff, "Information Transmission Under Conditions of Sensory Shielding."
35. Taylor, *Superminds*, 52.
36. Taylor, *Superminds*, 166.
37. Ibid., 166.
38. Ibid., 166.
39. Ibid., 169.
40. Ibid., 169–172.
41. Ibid., 172.
42. Ibid., 172.
43. John Taylor, *Science and the Supernatural*, 1980.
44. Margolis, *Uri Geller*, 274.
45. Smith and Best, *Electromagnetic Man*, 87.
46. Ibid, 96.
47. Ibid, 89.
48. Ibid, 92.
49. Ibid, 97.
50. Ibid, 100.
51. Budden, *UFOs Psychic Close Encounters*, 15.
52. Budden, "The 'Quantock Horror' Revisited."
53. Shallis, *The Electric Connection*, 79.
54. Uman, *All About Lightning*, 129.
55. Corliss, *Handbook of Unusual Natural Phenomena*, 19. (Report originally appeared in *Weather*, 19: 228, 1964.)
56. Uman, "Some Comments on Ball Lightning."
57. Sagan, *Ball Lightning*, 3.
58. Devereux, *Earth Lights Revelation*, 15.
59. Ibid, 15.
60. Ibid, 15.
61. Ibid, 15.
62. Ibid, 280.
63. Corliss, *Handbook of Unusual Natural Phenomena*, 18.
64. "Granny Locke and the Mystery of the Min Min Light," *National Museum of Australia*, *www.nma.gov.au/exhibitions/eternity/mystery* (accessed 26 May, 2014).
65. Devereux and Brookesmith, *UFOs and Ufology*, 153–154.
66. Ibid, 153–154.
67. Ibid, 153–154.

68. Ibid, 153–154.
69. Story, *The Encyclopedia of Extraterrestrial Encounters*, 577.
70. Ibid, 577.
71. Constable, *The Cosmic Pulse of Life*, 49.
72. Chester, *Strange Company*, vii.
73. Story, *The Encyclopedia of Extraterrestrial Encounters*, 203.
74. Chester, *Strange Company*, 109.
75. Ibid, 109.
76. Ibid, 110.
77. Jennison, "Can Ball Lightning Exist in a Vacuum?"
78. Budden, *UFOs Psychic Close Encounters*, 134.
79. Jacob Aron, "Earth's Mantle Helps Hunt for Fifth Force of Nature," *New Scientist*, February 21, 2013, *www.newscientist.com/article/dn23202-earths-mantle-helps-hunt-for-fifth-force-of-nature.html#.UyKxOoXE6es* (accessed March 14, 2014).
80. Ibid.
81. DeMeo, *The Orgone Accumulator Handbook*, 12.
82. White, *Psychic Warfare: Fact or Fiction?*, 211.
83. Laura Sanders, "Quantum Entanglement Visible to the Naked Eye," *Wired*, September 28, 2009, *www.wired.com/2009/09/quantum-entanglement/* (accessed May 11, 2014).

Bibliography

Ahmad, Margaret, et al., "Magnetic Intensity Affects Cryptochrome-Dependent Responses in Arabidopsis Thaliana," *Planta* 225, February 2007.

Baker, Robin R., "A Sense of Magnetism," *New Scientist*, 87, No. 1219, September 18, 1980.

Becker, Robert O. and Selden, Gary, *The Body Electric: Electromagnetism and the Foundation of Life*, William Morrow and Company, Inc.: New York, US, 1985.

Becker, Robert O., *Cross Currents: The Promise of Electromedicine, The Perils of Electropollution*, Penguin Group (USA) Inc.: New York, 1990.

Berk, Michael, et al., "Do Ambient Electromagnetic Fields Affect Behaviour? A Demonstration of the Relationship Between Geomagnetic Storm Activity and Suicide," *Bioelectromagnetics* 27, February 2006, 151–5.

Bise, William, "Low Power Radio Frequency and Microwave Effects on Human Electroencephalogram and Behavior," *Physiological Chemistry & Physics* 10, 1978, 387–398.

Broughton, Richard S., *Parapsychology: The Controversial Science*, Random House, Inc., New York, US, 1991.

Budden, Albert, *UFOs Psychic Close Encounters*, Blandford, UK, 1995.

Budden, Albert, "The 'Quantock Horror' Revisited," *The Ley Hunter*, No. 122, 1994.

Burch, J.B., et al., "Geomagnetic Disturbances Are Associated With Reduced Nocturnal Excretion of A Melatonin Metabolite In Humans," *Neuroscience Letters*, Vol. 266, Issue 3, May 14, 1999, 209–12.

Burda, Hynek, et al., "Extremely Low-Frequency Electromagnetic Fields Disrupt Magnetic Alignment of Ruminants," *Proceedings of the National Academy of Sciences*, Vol. 106, No. 14, April 7, 2009.

Cayce, Edgar and Auken, John Van, *Toward a Deeper Meditation: Rejuvenating the Body, Illuminating the Mind, Experiencing the Spirit*, A.R.E Press, Virginia Beach, VA, 1992.

Chester, Keith, *Strange Company: Military Encounters with UFOs in WWII*, Anomalist Books, US, 2007.

Clarkson, Michael, *The Poltergeist Phenomenon: An In-depth Investigation Into Floating Beds, Smashing Glass, and Other Unexplained Disturbances*, New Page Books, US, 2011.

Clow, Barbara Hand, *Liquid Light of Sex: Kundalini, Astrology, and the Key Life Transitions*, Bear & Company, Rochester, VT, 1991.

Constable, Trevor James, *The Cosmic Pulse of Life: The Revolutionary Biological Power Behind UFOs*, Borderland Sciences Research Foundation, US, 1976.

Cooper, Mary Ann and Price, Timothy G., "Electrical and Lightning Injuries," *Rosen's Emergency Medicine: Concepts and Clinical Practices*, 6th Edition, 2006.

Cooper, Mary Ann, et al., "Lightning Injuries," *Wilderness Medicine*, Ed. Paul S. Auerbach, 5th Edition, Mosby Elsevier, 2007, 67–108.

Corliss, William R., *Handbook of Unusual Natural Phenomena*, Gramercy Books, US, 1977.

Crichton, Michael, *Travels*, Alfred A. Knopf, Inc., US, 1988.

DeMeo, James, *The Orgone Accumulator Handbook: Construction Plans, Experimental Use and Protection Against Toxic Energy*, Natural Energy Works, US, 1989.

Devereux, Paul, and Brookesmith, Peter, *UFOs and Ufology: The First 50 Years, Blandford*, UK, 1998.

Devereux, Paul, *Earth Lights Revelation*, Blandford Press, UK, 1989.

Eder, Stephan H. K., et al., "Magnetic Characterization of Isolated Candidate Vertebrate Magnetoreceptor Cells," *Proceedings of the National Academy of Sciences*, Vol. 109, No. 30, 2012.

"The Electrical Girl," *The Popular Science Monthly*, Vol. 6, No. 33, March, 1875, 588–592.

Eltiti, Stacy, et al., "Development and Evaluation of the Electromagnetic Hypersensitivity Questionnaire," *Bioelectromagnetics* 28, 2007, 137–151.

Evans, Hilary, *The SLI Effect: Street Lamp Interference: A Provisional Assessment*, ASSAP, 1993.

Evans, Hilary, *SLIDERS: The Enigma of Streetlight Interference*, Anomalist Books, San Antonio, Texas, 2010.

Foley, Lauren E., et al., "Human Cryptochrome Exhibits Light-Dependent Magnetosensitivity," *Nature Communications* 2, June 21, 2011.

Frey, Allan H., "Human Auditory System Response to Modulated Electromagnetic Energy," *Journal of Applied Physiology* 17, 1962, 689–692.

Friedman, John S., *Out of the Blue: A History of Lightning: Science, Superstition, and Amazing Stories of Survival*, Random House, Inc., New York, 2008.

Guy, A. W., et al., "Long-Term, Low-Level Microwave Irradiation of Rats," *Bioelectromagnetics* 13, 1992, 469–496.

"A Human Electric Battery," *Saint John (N.B.) Daily Sun*, 23 June, 1879.

Jennison, R. C., "Can Ball Lightning Exist in a Vacuum?" *Nature*, Vol. 245, No. 5420, 1973, 95.

Johnsen, Sönke and Lohmann, Kenneth J., "Magnetoreception in Animals," *Physics Today*, March 2008.

Johansson, Olle, "Disturbance Of The Immune System By Electromagnetic Fields: A Potentially Underlying Cause For Cellular Damage And Tissue Repair Reduction Which Could Lead To Disease And Impairment," *Pathophysiology* 16, August 2009, 157–177.

Kalweit, Holger, *Shamans, Healers, and Medicine Men*, Shambhala Publications, Inc., US, 1992.

Kirschvink, Joseph L., et al., "Magnetite Biomineralization in the Human Brain," *Proceedings of the National Academy of Sciences*, Vol. 89, August 1992, pp. 7683–7687.

Kruszelnicki, Karl S., *Curious and Curiouser*, Pan Macmillan Australia Pty Ltd, Sydney, 2010.

Landgrebe, Michael, et al., "Association Of Tinnitus And Electromagnetic Hypersensitivity: Hints For A Shared Pathophysiology?," *PLOS ONE* 4, Mar 27, 2009.

Levallois, Patrick, et al., "Study of Self-Reported Hypersensitivity to Electromagnetic Fields in California," *Environmental Health Perspectives* 110, August, 2002, 619–623.

Levitt, B. Blake, *Electromagnetic Fields: A Consumer's Guide to the Issues and How to Protect Ourselves*, Harcourt Brace & Company, USA, 1995.

Lilienfeld, Abraham M., et al., "Foreign Service Health Status Study," *The Johns Hopkins University School of Hygiene and Public Health, Baltimore*, US, 1978.

Manning, Matthew, *In the Minds of Millions*, W. H. Allen & Co. Ltd., UK, 1977.
Manning, Matthew, *The Link: The Extraordinary Gifts of a Teenage Psychic*, Colin Smythe Ltd., UK, 1973.
Margolis, Jonathan, *Uri Geller: Magician or Mystic?*, Orion Books Ltd., UK, 1998.
"Microwaves Promote Cancer," *Microwave News*, Vol. 4 No. 6, July/August, 1984.
McCarty, David E., et al., "Electromagnetic Hypersensitivity: Evidence for a Novel Neurological Syndrome," *International Journal of Neuroscience* 121, 2011, 670–676.
Neihardt, John G., *Black Elk Speaks: Being the Life Story of a Holy Man of the Oglala Sioux*, State University of New York Press, US, 2008.
"Non-ionizing Radiation, Part 1: Static and Extremely Low-Frequency Electric and Magnetic Fields," *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*, Vol. 80, 2002.
"Poisoned Convicts Become 'Electrified'!" *Electrical Experimenter*, Vol. III, No. 86, June 1920, 185.
Roll, William G., et al., "Case Report: A Prototypical Experience Of 'Poltergeist' Activity, Conspicuous Quantitative Electroencephalographic Patterns, and Sloreta Profiles—Suggestions For Intervention," *Neurocase*, Vol. 18, Issue 6, 2012, 1–10.
Radin, Dean, *Supernormal: Science, Yoga, and the Evidence for Extraordinary Psychic Abilities*, Random House, Inc., US, 2013.
Rubin, James, et al., "Electromagnetic Hypersensitivity: A Systematic Review of Provocation Studies," *Psychosomatic Medicine* 67, Mar–Apr 2005, 224–232.
Sachs, Melanie, *Ayurvedic Beauty Care: Ageless Techniques to Invoke Natural Beauty*, Lotus Press, USA, 1994.
Sagan, Paul, *Ball Lightning: Paradox of Physics*, iUniverse, Inc., US, 2004.
Shallis, Michael, *The Electric Connection: It's Effects on Mind and Body*, New Amsterdam Books, New York, 1988.
Smith, Cyril W. and Best, Simon, *Electromagnetic Man: Health and Hazard in the Electrical Environment*, J. M. Dent and Sons, Ltd., UK, 1989.
Smyth, Albert Henry, *The Writings of Benjamin Franklin*, Vol III, 1750–1759, Haskell House Publishers Ltd., New York, 1970.
Stenhoff, Mark, *Ball Lightning: An Unsolved Problem in Atmospheric Physics*, Kluwer Academic/Plenum Publishers, New York, 1999.
Sting, *Broken Music: A Memoir*, Random House, Inc., New York, 2003.
Story, Ronald D., *The Encyclopedia of Extraterrestrial Encounters*, New American Library, US, 2001.
Strassman, Rick, *DMT: The Spirit Molecule: A Doctor's Revolutionary Research into the Biology of Near-Death and Mystical Experiences*, Park Street Press, Rochester, VT, 2001.
Taylor, John, *Science and the Supernatural*, Maurice Temple Smith Ltd., UK, 1980.
Taylor, John, *Superminds: An Enquiry Into the Paranormal*, Macmillan London Ltd., UK, 1975.
Targ, Russell and Puthoff, Harold, "Information Transmission Under Conditions of Sensory Shielding," *Nature*, Vol. 251, No. 5476, 18 October 1974, 602–607.
Uman, M. A., *All About Lightning*, Dover Publications, Inc., US, 1971.
———. "Some Comments on Ball Lightning," *Journal of Atmospheric and Terrestrial Physics*, Vol. 30, No. 6, 1968, 1245–1246.

Westby, G. W. Max and Partridge, Karen J., “Human Homing: Still No Evidence Despite Geomagnetic Controls,” *The Journal of Experimental Biology*, No. 120, January 1, 1986, 325–331.

White, John, ed., *Psychic Warfare: Fact or Fiction?*, Thorsons Publishing Group, UK, 1988.

Wilson, B. W., “Evidence for an Effect of ELF Electromagnetic Fields on Human Pineal Gland Function,” *Journal of Pineal Research* 9, 1990, 259–69.

Wilson, Colin, *Mysteries: An Investigation Into the Occult, the Paranormal and the Supernatural*, Granada Publishing Ltd., UK, 1979.

About the Author

LOUIS PROUD is a writer and researcher specializing in anomalous, or Fortean, phenomena. He was born in the remote town of Laura, South Australia, but spent the majority of his childhood in Tasmania and rural northern New South Wales. Some of his earliest and fondest memories are of watching his father conduct backyard science experiments involving Tesla coils and other electrical contraptions. So far as he is aware, he is the only person in history to have been granted by a high school teacher an award in "Parasite Psychology," for continually disrupting the class with remarks about parapsychology.

Louis studied writing and editing at Royal Melbourne Institute of Technology. He wrote his first book, *Dark Intrusions: An Investigation Into the Paranormal Nature of Sleep Paralysis Experiences*, while in his early 20s, receiving praise from Colin Wilson as "one of the most acute commentators on the paranormal to appear in recent years…" He gave up a career as a fitter and machinist in an automobile factory in order to focus on his second book, *The Secret Influence of the Moon: Alien Origins and Occult Powers. Strange Electromagnetic Dimensions: The Science of the Unexplainable* is his third book.

Louis's articles have appeared in *New Dawn*, *Paranormal*, *FATE*, and *Nexus* magazines, and he has been interviewed on such programs as "VERITAS Radio," "Paranormal Realms," and Whitley Strieber's "Dreamland." He currently lives in Darwin, Northern Territory, a city famous for its spectacular displays of lightning. In his free time he enjoys watching sci-fi movies and reading sci-fi novels, nature photography, and spending time with his wife. He can be contacted via his blog: *http://louisproud.net/*